THURSDAY, JULY 27, 1882

THE MODERN APPLICATIONS OF ELECTRICITY

The Modern Applications of Electricity. By E. Hospitalier. Translated and Enlarged by Julius Maier, Ph.D. (London: Kegan Paul, Trench, and Co., 1882.)

THIS book professes to be a popular account of all the more important practical applications of electricity that have during the last five years drawn so much public attention to that science. No better popular book than that of M. Hospitalier has appeared, and were it not for certain defects, chiefly of style, the present translation by Dr. Julius Maier would have been admirable. It deals in a fairly easy and at the same time fairly accurate manner with many technical matters, and will no doubt prove a very popular work. Part I. treats of the sources of electricity—batteries and dynamo-electric machines. Part II., which is naturally the largest section of the work, is devoted to Electric Lighting. Part III., the least satisfactory perhaps of the whole, and the one that has suffered most by the fact of being a translation of a foreign work, comprises Telephones and Microphones. In the fourth and last section a number of miscellaneous applications are described, including Electric Motors.

We have referred above to certain defects of style apparent in the work before us. It is unusual, to say the least, to speak of the "blades" of a battery in referring to the plates of metal or electrodes. Still less usual is it to call the electrode-poles "rheophores"; a term which probably a great many electricians in this country have never used and do not know of. Neither is it usual to speak of a steam-engine as a "vapor-motor." There are objections against the novel use made by the author or his translator of the term "electrodynamic" as a general adjective to comprise both "magneto-electric" and "dynamo-electric" machines. The word "electrodynamic" has already its own accepted use in the science; and if any extension of that use is necessary, all analogy requires that that extension should be in a direction different from that attempted. It is a dangerous experiment in a "popular" book to meddle with accepted technical terms; for besides being misleading to the public when they subsequently attempt to read other and more strictly scientific books, it makes the author of the popular work look as if he did not understand what he was writing about, when he uses accepted terms in a meaning other than their accepted one. There are other points that strike one as defects. What will the ordinary reader make out of such a sentence as that with which Chapter I. opens? "We can form a fairly exact idea of a battery by comparing it to a focus (*sic*) of heat; *for instance, the furnace of a boiler*." Or this (p. 14): "To continue our comparison between a battery, the focus of electricity and a focus of heat, we say that *polarisation in a battery is analogous to the want of draught in a chimney*." This precious piece of nonsense is nearly equalled by the following: "The battery is only used now *in law courts, in national assemblies*, and by some experimenters who for some reason or other cannot set up a steam or gas motor." (These italics are ours.)

But worse than these mild absurdities there are a few positive errors which no reviewer can conscientiously pass over. There is so much that is excellent in M. Hospitalier's work, that it might seem ungracious to point them out. But the only way to keep up the standard of popular scientific works is to point out where their scientific sins lie. In a section devoted to electrical units, we are first told that the "unit of intensity" is the *ampère*. As the author habitually uses "intensity" for electromotive force ("it corresponds to what the French call 'tension,'" he says), we must beg to remark that the definition is wrong. But the book goes on to say (p. 8):—"The ampère is really a perfectly distinct *quantity* of electricity, as a litre is a definite volume, and a kilogramme is definite weight." Wrong again; for the ampère is the standard unit of *strength of current*, and not of either "intensity" or "quantity." To make matters worse, the author adds the following explanation:—"If we say that the intensity of the current traversing a wire is one ampère, we mean by that that the quantity of the current traversing this wire *during one second*, if the current preserves the same intensity, is one ampère." This statement is happily contradicted by one standing on the opposite page of the book, namely, that "a current with an intensity of one ampère yields per second a quantity of electricity equal to one coulomb." But how is the unfortunate reader to know which of these to believe?

The author and translator are more at home in the applications of electricity. Here, however, we must protest against several misstatements and errors. On page 81 comes the preposterous dictum that "*Edison's coil is exactly like Gramme's*," a statement so absurd that we have only to remind the reader that the Edison armature, so far from being like that of Gramme, coiled on an iron *ring*, is so precisely like that of Siemens, wound shuttlewise along a *cylinder*, that, as everybody knows, Edison pays Siemens a royalty for the use of this principle. At another part of the book the armature of the Brush machine is said to be "in principle a Pacinotti's ring," but of that famous machine which anticipated that of Gramme, not only in the employment of a ring-armature but in the application of the segmental collector or commutator, and which differs from Brush far more than it differs from Gramme, the authors maintain a complete silence. They speak of the Gramme "collector" as though Pacinotti had never existed.

Turning to incandescent lamps, we find those of Swan, Lane-Fox, and Maxim, fairly described; and due credit is given to these pioneers of the principle of the incandescent lamp. But of Edison's lamp a very poor account indeed is vouchsafed; the filament-lamp of charred bamboo being just casually mentioned, whilst his older lamp, with its horse-shoe of stamped paper, is figured and described in detail.

In describing Faure's accumulator, a modification (due, we believe, to Dr. Fleming) consisting of a number of lead trays, coated with red lead and piled up vertically, is mentioned as if this were the original form. Moreover, we doubt whether "the happy idea of *filling up* the space between the lead plates used by Planté with red lead," would by any means produce the result of "vastly increasing the usefulness" of that excellent apparatus: it would rather destroy it by short-circuiting it.

Lastly, we must protest against the treatment given to Reis's Telephone, of which the book declares that it "has always remained a purely musical apparatus." It is perfectly clear that neither M. Hospitalier nor Dr. Maier can have read Reis's own papers when they make this assertion, which those papers amply refute, and which a careful trial of Reis's own instruments will also amply contradict. Reis invented his instrument, taking the human ear as pattern, *because* the human ear can vibrate to all kind of sounds. He invented it, meaning it to transmit speech, and though it transmitted music better than speech—and both imperfectly—it did, to a certain degree, fulfil its inventor's aim. The author seems in fact to have viewed Reis's invention through the hazy medium of the writings of Count du Moncel, or some less reliable authority; for he mentions Yeates's experiments of 1865 (in which articulate speech was transmitted by a modified Reis instrument with such accuracy that the voices of individual speakers were recognised), and then adds: "The musical telephone might have become an articulating telephone under these conditions, *but this result was not obtained*, partly on account of the imperfection of the instrument, and *partly because Yeates had no such result in view!*" How this extraordinary distortion of well-known facts has crept into the book before us we are at a loss to conjecture. Doubtless the numerous excellent illustrations with which the book is adorned will procure for it a ready sale.

HANDBOOK FOR NORTHERN AND CENTRAL JAPAN

A Handbook for Travellers in Central and Northern Japan, &c., with Maps and Plans. By Ernest Mason Satow, Second Secretary and Japanese Secretary to H.B.M. Legation, and Lieut. A. G. S. Hawes, Royal Marines (Retired). (Yokohama: Kelly and Co.; Shanghai: Kelly and Walsh, 1881.)

AS a mere handbook this work is indispensable to the European traveller in Japan. But it is much more than a handbook, it not only indicates what is sightworthy, but explains by illustrative myth or legend, drawn from local tradition or from the little explored treasures of Japanese literature, the special interest with which mountains, temples, mounds, groves, and places are invested in the eyes of such Japanese as have not yet abandoned their nationality. To readers of this journal the most valuable portion of the book will be the description as accurate as minute of the Alpine region formed by the provinces of Etchiu and Hida (now the prefectures of Ishikawa and Gifu)—a region difficult of access even to natives, and almost untrodden by Europeans. The mountain range bounding this wild and remote tract on the East is the most considerable in Japan, extending nearly due north and south for some sixty or seventy miles, and rugged with innumerable peaks, the most conspicuous of which, beginning from the north, are Tatéyama, 9500 feet, Goroku-daké, 9100 feet, Yari-ga-také, 10,000 feet, and Norikura, 9800 feet. The chain is not of homogeneous structure, nor are the peaks of contemporaneous origin. The basis is a closegrained granite, not unfrequently rich in garnets. Through this backbone or axis vast masses of igneous and volcanic rock have been extruded, the volcanic rock principally trachytic, often coarse-grained, and occasionally (Tate-yama) columnar. Of the peaks, Yari-ga-také (spear-peak) seems the most ancient, and consists of an intensely hard, foliated rock with curiously contorted siliceous bands and of an almost equally hard porphyry breccia. Nori-kura (ride-saddle) and Tatéyama (steep-hill) are both volcanic. Goroku-daké or Renge (Lotus flower Peak) consists of a mass of trachytic porphyry piled upon and against a close-grained granitic rock. The lower slopes of the range are overlaid, say our authors, by sedimentary rocks, but I am inclined to doubt the accuracy of this statement. Under the fierce sun and incessant rain of summer aërial denudation proceeds at a great rate, especially in the granitic districts of Japan, as may be well seen in the neighbourhood of Kobé, and the existence of a quasi-sedimentary rock may thus be easily accounted for. But true sedimentary rocks, excluding lacustrine deposits or fluvial alluvia, require the agency of the sea, and the greater part of the covering strata of the Japanese islands, is of very recent origin, and has never been under the sea. Only for a few days in early autumn does snow disappear from these peaks, the curiously abrupt and jagged outlines of which recall and even justify the mountain-forms common in Chinese pictures. The fauna of the district is little known. Ptarmigans are common, so also are flying squirrels, as well as bears, two species, of wild boar, and the curious goat-faced antelope. The flora has been more studied. Dense forests clothe the slopes, principally of beech and of several species of oak, mostly evergreen. Conifers are less abundant than is common in Japan. But the pretty 5-leaved *Pinus parviflora*, S. and Z., as well as, though to a less extent, *Cryptomeria japonica*, *Chamæcyparis obtusa*, S. and Z., and *C. pisifera*, S. and Z., are not infrequent. I am not sure, for reasons too long to state here, that the Cryptomeria, despite its frequency, is indigenous to Japan. Two or three kinds of Betula show themselves at elevations of 4000-5000 feet. Below this level many examples of the genera Epilobium, Scabiosa, Hypericum, Parnassia, Euphrasia, Lilium (*L. auratum* and *L. tigrinum*), Hydrangea, Smilax, Akebia, Tylophora, &c., constitute a vegetation by no means without a western European aspect. Above 5000 feet Vaccinium, Diphylleia, Trollius, Paris, *Fragaria vesca*, and Anemone make their appearance. The common Pinguicula is also found, and probably *Loiseleuria procumbens*, which I have gathered on the slopes of Asama-yama, finds a home on those of the Hida mountains. Above 8000 feet a small Dicentra (*D. pusilla*, S. and Z.?), a yellow violet, *Shortia uniflora*, and *Schizocodon soldanelloides* are to be seen interspersed among bushes of a dwarf azalea. But it is doubtful whether any true Alpine flora exists in Japan.

On Taté-yama the climber passes by some hexagonally columnar examples of andesite, said to have been originally prostrate trunks of trees over which a woman incautiously stepped, which so offended the deities that they were changed into useless blocks of stone. The spot is called Zai-moku-zaka or timber-steep to this day, in commemoration of the fact. Solfataras, it should be mentioned, are as common in this district as in other parts of Japan. A curious means of crossing deep ravines and precipitously walled valleys, known as Kago-

no-watashi—basket-crossing—is much used in these provinces. A sort of wicker cradle is suspended on hempen ropes slung across the valley, and is drawn by lines to one side or the other, or, as is more usually the case, the peasant crosses without assistance. Entering the cradle, he seizes the ropes above with his hands, and by a series of dexterous jerks, needing considerable practice for their due accomplishment, takes himself and the cage across. The great danger seems to be that of getting the cradle from under him, and thus leaving his body suspended in mid-air. His struggles are represented no less quaintly than vigorously in a drawing by Hokusai, to be found in the 13th volume of his Manguwa, or Rough Sketches.

A distinguishing feature of the book is the elaborate account given of the principal mountains, most of which have been ascended by the authors. Fuji, of course, is the highest, Dr. Rein making it 12,280 feet, Mr. Stewart 12,365 feet. The curiously jagged outline of the comparatively narrow rim of the crater shows doubtless that the broad deep cavity, of which the diameter is about 1500 feet, and the depth about 550 feet, was usually full of boiling lava, spurted up from time to time in the manner described by Miss Bird in her graphic description of the great volcanic districts of Kilauea and Mauna Loa. It is not mentioned that the two wells on the summit, on the edge almost of the crater itself, the Famous Golden Water and the Famous Silver Water, derive their supply from hoards of snow preserved by overlying masses of wind-heaped scoriæ, and volcanic dust from perishing under the fiery rays of the summer sun. One of the most interesting of the many peaks which Messrs. Satow and Hawes are the only Europeans who have ascended, is Mount Ganjiu, of which the shapely outlines rise in beautiful logarithmic curves high over the plains of Nambu. The mountain consists of three volcanic cone-frusta "telescoped" into each other. The lower cone is of course the oldest, the rim of its crater being still distinct at a height of about 5000 feet. A smaller cone about 600 feet high, rises within this, the rim of the crater of which is nearly equally distinct, and a third and smallest cone tops all, having a height of not more than 100 feet, and showing a crater at its summit, from which jets of steam still issue.

It is noteworthy that in Japan the names of rivers, capes, plains, and villages are usually pure Japanese, those of mountains more commonly Chinese. Some of the place names in the northern part of the main island have a distinctly Aino character, for instance, such a name as Namakunai, and many of the names ending in "bé," a corruption of "betsu," the Aino word for river.

Two capital maps accompany the book, which the stay-at-home reader will find as full of curious lore as the traveller of valuable information.

FREDK. V. DICKINS

OUR BOOK SHELF

Studies in Nidderdale. By Joseph Lucas, F.G.S., F.M.S., Telford Medallist of the Institution of Civil Engineers, Associate of the Institute of Surveyors. (London: Elliot Stock. Pateley Bridge: Thomas Thorpe.)

THIS book is the result of notes and observations other than geological, made in Nidderdale during the progress of the Government Geological Survey of that district, between the years 1867 and 1872.

Nidderdale is a remote pastoral valley, formed by the River Nidd, which takes its rise near the mountains of Great and Little Whernside, and which, after a course of about thirty-five miles, joins the Ouse near York.

The basin of the Nidd, above Hampsthwaite, includes an area of eighty square miles, and for sixteen miles from Great Whernside, the valley proper is nowhere more than one mile wide from ridge to ridge, and is from 500 to 800 feet deep, forming as it were a deep groove in the vast easterly sloping heather-covered moorland.

After a few introductory remarks upon the geology and geography of Nidderdale, Mr. Lucas deals with the cattle, sheep, and other matters connected with the farm, including instructive and exhaustive discussions upon the various names. In the dairy department we have the *kern* (old Norse, kirna—a churn), now a revolving barrel or tub, on a horizontal axis, the *sile* (old Norse, sahl—a sieve), and *sine*, Saxon *sihan*—to strain; and the "lile roond thithel" for stirring cream. The old cheese press is described in detail, and there is an excellent drawing of a very old form of that dairy implement, very like such as we remember to have seen long ago in remote rural districts in the north. Then there is a very interesting chapter upon the farm itself, in which Mr. Lucas introduces a farmer speaking in the dialect, and describing by their appropriate names and uses, the various buildings, fields, and animals to be found upon his farm; interspersed with these the author has put the various Norse, Anglo-Saxon, or Celtic words, from which many words in the folk speech have been derived, so that we have a means of tracing the sources of the dialect while we are becoming acquainted with its local use.

Mr. Lucas must have had opportunities such as very few others could have had, to trace out the natural science of the district, and as the passage will give a good idea of concise and clear style in which the book is written, we give an extract from the chapter on "Vestiges of the Ancient Forest."

"Nidderdale and its moors have formerly been covered by an extensive forest. Many trees lie buried in the peat upon the moors. In the thousands of sections made by little water-courses, the birch appears almost everywhere predominant. Hazel 'sealh' (willows), thorn, oaks, &c., also occur, but the birch must have formed a thick and almost universal forest by itself, such as may be seen on the west coast of Norway at the present day. The upper parts of the moorland gills, and much of what is now the moors, must formerly have made a beautiful appearance with its light gauze-like forest of birch and mountain-ash. The last surviving example on any considerable scale is present in Birk Gill, a tributary of the River Burn. The run of the Gill is north-west to south-east. The Gill is about 400 feet deep at its mouth, and half a mile wide from ridge to ridge. Like all other valleys of the same elevation in these hills, it is boat-shaped in section, the beck running in a deep ravine at the bottom. The sides of the hills are wild heathery moorland, crowned with fine lines of crags down to the edge of this ravine in which the native forest is preserved. There is no cultivation in the Gill, the bottom of which is about 600 feet above the sea at its mouth. The belt of wood clothes the sides for 200 feet, or up to 800 feet near its mouth, and ends where the stream reaches 900 feet in a distance of rather more than a mile. Above this the stream is called Barnley Beck. The wood consists of mountain ash, alder, oak, ash, birch, holly, and thorn, running above the edge of the cleft with a delightfully irregular and feathery margin on the ling covered moor." Subjoined to this is an elaborate table giving the aspect, height, and soil of the various trees found in this valley. A chapter is devoted to the modern botany of the valley, upon which there are also valuable notes in the introduction by Mr. J. G.

Baker, F.R.S., of Kew Gardens. Mr. Lucas is by no means backward in acknowledging by whom he has been aided in the completion of the work, and amongst others there are numerous and valuable contributions by Mr. J. R. Dakyns, M.A., Cantab. (of H. M. Geological Survey), both in the foot-notes and in the text.

Notwithstanding this, however, the book is an original work, everywhere bearing abundant evidence that the materials have not been compiled, but in great part collected upon the spot, and carefully worked out by the author himself. And as there are many secluded valleys in Cumberland, Westmoreland, and Yorkshire, in which the customs, manners, and folk-speech differ very little from that of Nidderdale, we think the volume deserves a much wider circulation than in the district of that valley from which it takes its name. Six of the concluding chapters are devoted to the birds of Nidderdale. These chapters on natural history are the most pleasing in the book, and contain information respecting the distribution of many birds which is altogether new. After these there is a well-told story in the dialect ("Dicky and Micky Date") by Thomas Thorpe.

Probably the most valuable, and certainly the most laborious portion of the work, is the glossary of the dialects of Nidderdale, with which it concludes.

Local glossaries no doubt there are without number, of the northern dialects, but we have never before seen one which has traced with such clearness, both from its use and derivation, each word to its source. A residence of over forty years in some of those remote regions in which a corresponding dialect is spoken, enables us to testify that Mr. Lucas has been wonderfully accurate and exhaustive in laying hold of the vocables of the district; and the pains and skill with which he has traced them through the Norse and other cognate languages, must be seen before they can be properly understood. T. E.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Sun-spot Period

THE sight of my *bête noire*, that part of Wolf's sun-spot curve lying between the years 1766 and 1799, so clearly plotted in the communication by Prof. Stanley Jevons, on "The Solar-Commercial Cycle" (NATURE, vol. xxvi. pp. 226–28), impels me to offer some remarks having special reference to solar periodicity at that time.

In a paper read at the meeting of the British Association in York last year, I ascribed the sun-spots to planetary tides in the solar atmosphere. It is not pretended that what was advanced amounted to demonstration, but the assumption had this practical result—it led me to the conclusion that the sun-spot maxima and minima, recognised in what is known as the sun-spot period, are, on the whole, determined by the relative positions of the planets Venus, Earth, and Jupiter. The maxima are nearly always associated with configurations in which Venus and Earth in conjunction or opposition, have Jupiter in or near syzygy or quadrature; while the minima are even more certainly associated with configurations in which Venus and Earth in conjunction or opposition, have Jupiter in or near the octant.

There are, however, significant deviations from this general law, and the maximum to which Wolf assigns the date 1788·1 occurs at a time when the law would give a minimum. Now it may be admitted, that at times special conditions prevail, arising from changes within the sun itself, or from the advent of material agglomerations foreign to our system. I prefer, nevertheless, to assume for the present, that the explanation of such periodicity as has been established is within the resources of a planetary hypothesis. Accepting the sun-spot record as read for us by Prof. Wolf, because we have nothing better, it is inferred that the apparent anomalies of the period in question are due to exceptional planetary configurations.

The following statement shows how lamentably observation and theory are at variance, in regard to the sun-spot numbers, near the dates 1778 and 1789:—

Years of Maximum Annual Sun-Spot Numbers

Observation				
1761	1769	1778	1789	1804
Hypothesis				
1761	1771	1783	1794	1804

The remarkable series of corn-prices, as given by Prof. Jevons, however shows maxima so fairly in accord with the hypothetical maxima that I am tempted to quote them:—

Years of Maximum Corn-price at Delhi

1763	1773	1783	1792	1803

If this relation is anything more than a coincidence, an important question arises. Are we to consider the sun-spot record defective, and reject the maxima of 1778 and 1789, because they cannot be traced in the corn-prices? Not necessarily, it seems to me. The sun-spot record may not be reliable, and with its revision difficulties may vanish, but there is something very substantial about the maximum of 1789, and it must be remembered that it is one thing to measure a sun-spot, and quite another thing to use a sun-spot as a measure. The sun-spot tells of solar disturbance, but the attendant changes in solar radiant forces will be changes in quality as well as in quantity, and it may be taken for granted that there are solar periods that are not to be found in the sun-spot numbers directly. One outcome of the researches of Dr. Köppen has been the recognition of what is called the period of the "Umkehrung," or inversion, so named because the more usual relations of sun-spots and air temperatures are supposed to be reversed during this particular period, which lies between the years 1770 and 1816, or thereabouts. Double-edged weapons are, however, dangerous, and must be used with caution.

Sun-spot measurement itself is a somewhat arbitrary process. The "relative number" for a given day is ten times the number of groups, plus the number of individual spots; while the method initiated by the Kew observers, and now adopted at Greenwich, gives "spotted area," that is, the proportion of the sun's surface covered by such spots as may be visible on that day. It would be interesting to compare the positions of the great spots seen in April last, as given on the annual sun-spot rolls at Zürich and Greenwich respectively. Moreover, certain well-marked distinctions in the character of the disturbance have no place, or next to none, in sun-spot measure—the faculæ are ignored, while umbra and penumbra are lumped together.

It should be remarked that observation and hypothesis agree in the total number of periods, so that, the length of the mean sun-spot period remains unaltered, unless it is decided that certain observed maxima may be taken in addition to the hypothetical maxima, and not as replacing them. The planetary hypothesis requires that the sun-spot series shall be considered as a compound series, representing a number of more or less important series of planetary periods, and it is to be expected that at times there will be a difficulty in tracing any dominant series of periods, whether primary or derivative.

It seems to me that too much importance is apt to be attached to the *mean* sun-spot period, seeing that its occurrence is exceptional, and the departure from it very considerable.

That these observations should be inconclusive is a matter of course, but my purpose will be served, if they tend to produce the impression, that there may be no real solution of continuity in the relation between the sun-spot numbers and the particular series of planetary periods that I believe to give "the sun-spot period" a rational basis. F. B. EDMONDS

72, Portsdown Road, London, W., July 14

Messrs. McAlpine's Atlases

WILL you allow me space in your columns to make a few remarks upon the "Biological Atlas" of Messrs. D. and A. McAlpine, and the "Zoological Atlases" of the first of these gentlemen?

Mr. D. McAlpine was, some three or four years ago, a student

in the biological laboratory at South Kensington, and, after a diligent attendance at Prof. Huxley's eighty odd lectures, and at the five months' practical work, he succeeded in passing the examination in the second class. The two following years Mr. McAlpine, with laudable perseverance, again presented himself for examination, each time appearing a place or two lower in the second class.

While working at South Kensington Mr. McAlpine made several copies of the diagrams of type dissections in the laboratory, which diagrams are for the most part enlargements of my original drawings made by my friend and former colleague, Mr. G. B. Howes. I naturally imagined that Mr. McAlpine, like other students who had taken the same trouble, intended to use these copies either for his private work or for his classes in Edinburgh, and I was, therefore, greatly surprised at the appearance of the Biological Atlas, to find in it a number of marvellously inaccurate copies of these same diagrams, published not only without permission, but without the slightest reference to their source even in the preface.

In the Zoological Atlas (Vertebrata) the same thing occurs, and my diagrams, although strangely altered, are quite recognisable; in the figure of the skate's nervous system, for instance, I notice, copied with unusual accuracy, a mistake as to the origin of the orbito-nasal nerve, which occurred in my original drawing, but which has subsequently been corrected.

In the cases where Mr. McAlpine, having no diagrams to copy, has had to depend upon his own dissections and the statements in text-books, the results are sometimes remarkable. As an instance, I may take the ingenious diagram of the skate's vascular system, in which *paired* caudal veins are shown accompanying the caudal artery, and passing directly into the corresponding cardinal veins, the renal portal systems being completely suppressed.

According to the advertisements, the *Athenæum* recommends the "Biological Atlas" to all students of the subject; I regret that I cannot agree with your contemporary; in my opinion no books could possibly be more mischievous to a beginner than these, since they hold up for his example and imitation a work of the most inaccurate and slovenly description; as indeed, if possessed of ordinary powers of observation, he cannot fail to find out for himself before he has been a month at the subject.

T. JEFFERY PARKER

Otago University Museum, Dunedin, N.Z., March 24

Palæolithic Implements—New Localities in the Thames Valley, near London

IN NATURE, for July 15, 1880, p. 253, Mr. P. H. Pepys drew attention to a section then being made through beds of river gravel and brick earth near the West Drayton Station of the Great Western Railway. I had an opportunity of going to West Drayton on July 27, 1880, so I walked through the cutting towards Langley. My quest was for relics of primæval man, and I was rewarded by finding not only several flint flakes, but the butt end of a massive implement broken in Palæolithic times. This was just north of Langley Station, in Buckinghamshire, and the first Palæolithic relics, as far as I know, detected in that county. The workmen in the cutting for the new canal were such a rough lot that I found it impossible to fraternise with them, so my subsequent visits were all made on Sundays. During these walks I lighted on ten implements and a large number of flakes at Langley and Iver, all in the valley of the Coln, and a river until now (as far as I know) not described as implementiferous. In gravel brought from the pit close to Taplow Station I found a single implement, a large trimmed flake, and numerous simple flakes; this position is also in the county of Buckingham. At West Drayton, in Middlesex, in the valley of the Coln, I lighted on five implements and numerous flakes. East of West Drayton, in a pit near Botwell, in the valley of the Yedding Brook, hitherto undescribed as implement-bearing, I found a single implement; this was in the pit near Bull's Bridge. In the same valley at Hillington, and other places I have found several other implements. In all the excavations from Slough to Acton I have found both implements and flakes. In the new railway cutting from Gunnersbury to Hounslow I have found four implements, one close to Hounslow, a massive butt, and many flakes. This cutting has been a very interesting one, from the abundance of the fossil shells of fresh-water molluscs found in the sands, especially near the bridge under the Hanwell Road. One shell very abundant, and, as far as my observation goes, absent from the sands of North-east London, is *Achatina acicula*, Müll., kindly named for me by Dr. J. Gwyn Jeffreys. I believe this is the first record of fresh-water shells from the Palæolithic sands of the Ealing district. Since my paper on the Valley of the Brent was read before the Anthropological Institute, in June, 1879, I have found many more implements in the positions there mentioned. At North-east London, and especially in the Valley of the Lea, I have been able to greatly extend the range of Palæolithic man. In addition to the localities mentioned in my paper read before the Anthropological Institute, in June, 1878, and published in February, 1879, I am now able to mention London Fields, Homerton, in the south, a position south of Dalston Junction, and nearer the Thames than the places first given by me, Hackney, near the railway station, Abney Park Cemetery, South Hornsey, Highbury, Stamford Hill, Upper Edmonton, Lower Edmonton, Bush Hill Park, Forty Hill, Enfield, and Cheshunt; the pit at the last place, which formerly produced flakes only, has since furnished three implements—one an example of the first class. On the east side of the Lea I have found implements in the gravels of Stratford, Leyton, Leytonstone, Wanstead, Walthamstow, and Higham Hill—a magnificent example from the last place. Further east, and in the Valley of the Roding (first pointed out by me as a river bearing implements in its gravels)—at Barking—I have found two implements, and elsewhere in the neighbourhood, as at Ilford and Upton, numerous flakes. Still further east, at Gray's Thurrock, West Tilbury, and Southend, I have evidence of the presence of primæval man; at the latter place, a rude make-shift implement, and a scraping-tool with twin bulbs of percussion. These were found by my two sons. I have not mentioned all the positions I know in this letter, or re-mentioned those given in my two papers, but rather the positions I can afford to dispense with. It shows, however, especially when considered with the discoveries at Reading and Oxford, what a vast cohort of men once lived all along the Thames and its northern tributaries in Palæolithic times.

WORTHINGTON G. SMITH

125, Grosvenor Road, Highbury, N.

"Halo": Pink Rainbow

THE appearance noted in NATURE this week (p. 268) by Prof. O'Reilly must surely have been a case of the *rayons du crépuscule* that are frequently visible near sundown in the eastern sky. East-south-east cannot at this season be very far from opposite the setting sun. Prof. O'Reilly does not mention, though probably it was the case, that the point of convergence of the "beams" which he saw was diametrically opposite the sun's position. That these beams appeared dark is probably merely caused by the real "rayons" being wide, with narrow, darker interspaces between. I have several times (see *Phil. Mag.*, 1877) called attention to the existence of similar rays crossing the rainbow radially; indeed, it is seldom that a rainbow occurs when the sun is low in the sky, without one or more such rays being visible within the arc. Two such rays, for example, were visible in a bow seen here at sunset two evenings ago. This bow was interesting in another way also; for, like the "pink" rainbows about which there was some correspondence in NATURE last year, the only colours visible (in the primary arc) were red and yellow, the red being of a pinkish rather than a crimson hue.

SILVANUS P. THOMPSON

Pollokshields, Glasgow, July 20

Smoke Abatement

COUNT RUMFORD founded the Royal Institution of Great Britain nearly a hundred years ago, chiefly, I believe, to introduce improved grates, fireplaces, stoves, &c., as he then foresaw the necessity of economising coal and obtaining more complete combustion.

In about the year 1860 Faraday himself showed me Count Rumford's models, &c., and some of Rumford's working stoves in the model room in the Institution, a subject in which I was then much interested, as I was enlarging my own house.

About ten years ago, when the laboratory of the Royal Institution was enlarged, the models, stoves, &c., devised by Count Rumford were removed. It would be important to know what has become of them. Would you kindly allow me to ask this question?

A MEMBER OF THE ROYAL INSTITUTION

July 19

INTERNATIONAL POLAR OBSERVATORIES

ON August 1, it is hoped, that a ring of observing stations will begin work all round the pole. By this time all the expeditions that have been arranged for will either be on the way or on the spot. The readers of NATURE are doubtless familiar with the inception and progress of a scheme for Polar research which originated in 1875 with the late Lieut. Weyprecht, and has been gradually built up until it has assumed the proportions of a great international effort to obtain accurate scientific observations on the physical and biological conditions of the polar area. Our Map of the Arctic Regions will enable the reader to note the localities of the various stations, and the nationality of the observing parties in each case. Meantime it may be useful to give a brief history of the scheme, and a sketch of the programme which it is proposed to carry out. This we are enabled to do from the official documents issued by the International Polar Commission.

As we have already said, it was in 1875, at the forty-eighth meeting of the Association of German Naturalists and Physicists at Gratz that Lieut. Carl Weyprecht explained his views as to the proper basis for Arctic explorations. He showed that while the Polar regions undoubtedly offer one of the most important fields of investigation for all branches of natural science, this is especially the case with reference to inquiries into the physical condition of the earth. The numerous and costly expeditions which have hitherto been organised have, however, yielded comparatively insignificant returns, so that it may almost be said that they have merely contributed to show more clearly how important it would be for all branches of natural knowledge to have those regions explored in a thoroughly scientific way. The scientific results of Polar voyages hitherto have been very scanty, and have borne no proportion to the expenditure of money and labour involved in the expeditions. Weyprecht ascribes this principally to the circumstance that in these Polar voyages geographical discovery was always made the chief object, while scientific investigations were considered to be of secondary importance. He points out also the isolated character of the individual voyages, and consequently of the scientific observations taken during their continuance. The observations are therefore deficient in a qualification which is of great importance in Polar regions, viz. the possibility of a comparison with simultaneous observations at a number of other places. Lieut. Weyprecht therefore proposed to deviate from the principles which have hitherto ruled Polar explorations, by abandoning geographical discovery and particularly reaching the Pole, as the main object, and instead aiming at scientific observations, especially those of a physical character. He proposed that, instead of isolated voyages in the Polar regions, expeditions should be sent out, organised on a common plan, in order to take simultaneous physical observations, for a considerable space of time, at several different points around the Pole.

In conjunction with Count Wilczek, Lieut. Weyprecht drew out a programme for Polar research of this type which was submitted to the International Meteorological Congress, held at Rome in the spring of 1879. The Congress, when this programme was submitted to it, recognised the great importance of Weyprecht's proposals, and recommended it for adoption to all governments. Owing, however, to the fact that all the individual delegates to the Congress had not received definite instructions from their respective governments to deliberate upon such a scheme and to make the necessary arrangements for its execution, the International Meteorological Committee, appointed by the Congress, was instructed to summon a special conference to discuss the subject at Hamburg on October 1 next ensuing.

This conference was attended by nine delegates from the following states:—Austria, Hungary, Denmark, France, Germany, the Netherlands, Norway, Russia, and Sweden. It commenced its operations by the preparation of a detailed programme for the enterprise, and fixed as an indispensable condition of its success, that at least eight points in the Arctic regions should be occupied, and that the interval from the autumn of 1881 to the autumn of 1882 should be the period for the proposed twelve months' observations. The International Polar Conference finally, in order to ensure that due attention should be paid to the necessary arrangement in the different countries, constituted itself as a permanent International Polar committee, with the right of electing new members, and chose Dr. Neumayer as its president.

The second International Polar Conference at Bern in August, 1880, was attended by eight delegates from the same states as before, and in addition by a delegate from Italy, and at its later meetings Prof. Wild, the president of the International Meteorological committee, was present as a member. It appeared from the reports of the delegates that at that time four states had definitely promised participation in the scheme, by occupying stations in the Arctic regions, viz. Austria (Count Wilczek), Denmark, Norway and Russia. The Conference decided to postpone the commencement of operations for a year, *i.e.* till the autumn of 1882, in order to facilitate the timely co-operation of other countries, and the consequent fulfilment of the condition of the occupation of eight stations, which had been fixed by the Hamburg meeting. At this Conference Dr. Neumayer resigned the presidency of the committee, and Prof. Wild was elected to fill the vacancy. This Conference also published its protocols and a condensed report of its proceedings. The President, in May, 1881, announced that the carrying out of the complete scheme, by a sufficient number of observers, was secured by promises of the establishment of at least eight stations in the Arctic regions, and he consequently invited them to the projected third International Polar Conference at St. Petersburg, August 1, 1881.

The third International Polar Conference at St. Petersburg was attended by ten delegates from the States of Austria, Denmark, France, the Netherlands, Norway, and Sweden, of which, however, France and the Netherlands had not yet announced their definite participation in the undertaking, while Russia and the United States had promised to occupy two stations apiece.

Accordingly the Conference finally fixed the epochs of commencement and termination of the simultaneous observations at all stations, and adopted a definite programme for all stations, in as close accordance as possible with the resolutions of the Hamburg Conference, in so far as this appeared necessary for the comparability of the observations.

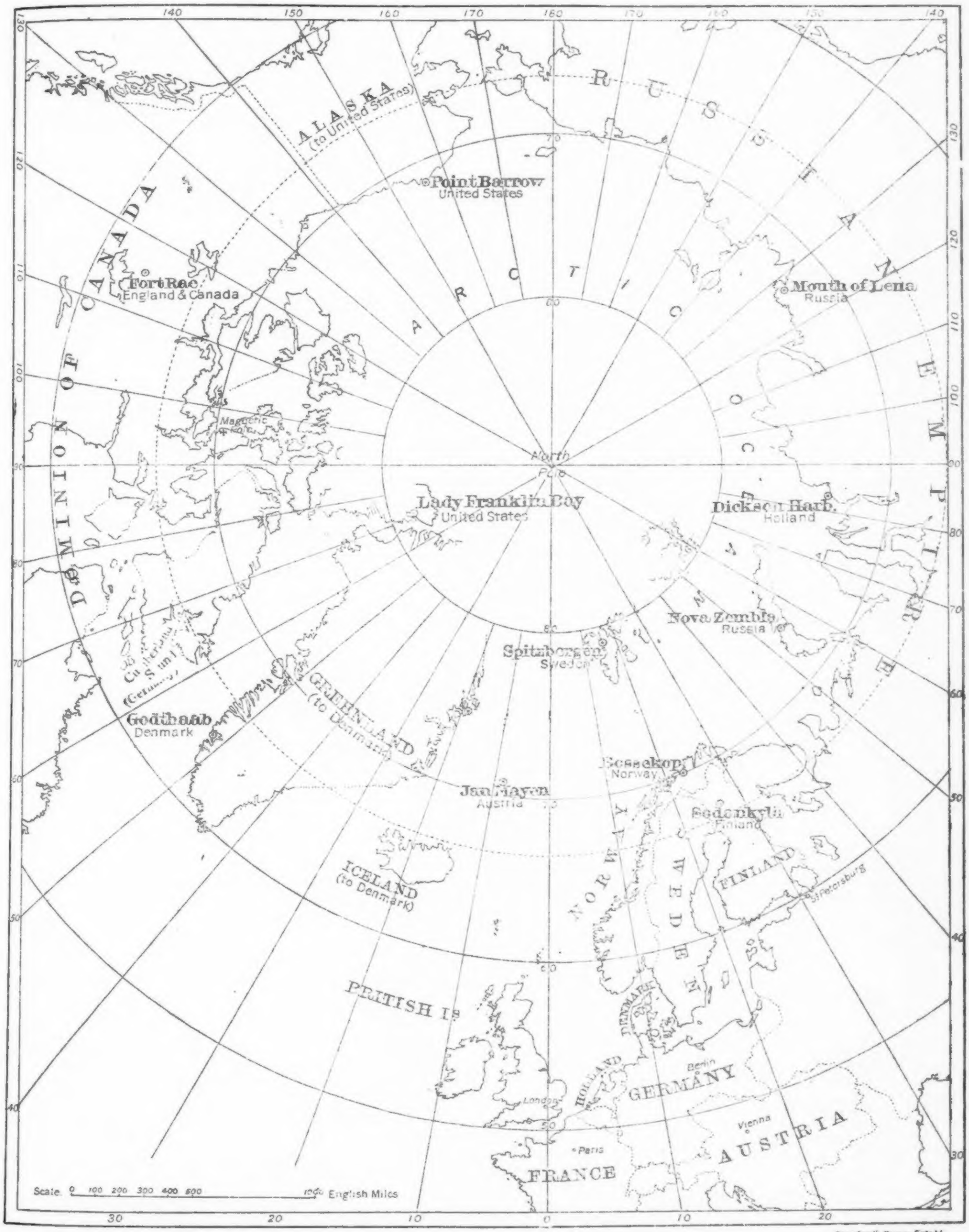
The Conference resolved to request the President and the other members to endeavour to secure that during the period of the Polar expeditions and their observations, the meteorological and magnetical observations in other zones, and the Royal and mercantile navies of each nation should be invited to furnish the data required for preliminary comparison, by more frequent observations, and particularly by observing the variations of magnetic instruments on the term days, and, moreover, that on these days and at times of magnetic disturbances the currents in the various telegraph lines should be specially and carefully studied.

The following is the programme which was adopted at the Conference at St. Petersburg for the observations to be made at the international Polar stations and for their first preliminary discussion:—

I. NECESSARY OBSERVATIONS

a. Beginning and Ending of the Observations

1. The international Polar stations are to begin their observations as soon as possible after August 1, 1882, and end them as late as possible before September 1, 1883.



Stanford's Geogr. Establ.

b. Times of Observation

2. The hourly magnetical and meteorological observations may be made according to any time, only the magnetical observations on the term days must always be made according to Göttingen time (mean civil time). The term days are always the 1st and 15th of every month, except January, where the 2nd is to be taken as the term day instead of the 1st.

c. Order of the Observations

3. The expeditions are free to choose the order of their observations as they think fit.

d. Meteorological Observations

4. Air. Temperature. The mercurial thermometers should be read to 0°·1 C., the spirit thermometers to at least 0°·5 C.

5. The thermometers should be verified at the Central Meteorological Offices, and the spirit thermometers besides are to be compared with a mercurial thermometer at the place of observation at as low temperature as possible. The zero point of all thermometers used in the observations is to be determined afresh from time to time.

6. The thermometers are to be placed at a height of at least 1½ to 2 metres above the ground, in a screen like that given by Wild, and which will secure that without excessive interference with the free circulation of the air about them they will be sheltered from all disturbing influences of radiation.

7. The minimum thermometer for the determination of air temperature must be placed under the same conditions as the other thermometers.

8. The temperature of the sea on the surface and at the depth of every 10 metres is to be observed wherever possible. The following are suggested as useful instruments for this purpose:—sluggish thermometers by Eckmann, Negretti and Zambra, Miller-Casella, &c.

9. Pressure. Every station must at least have a standard mercurial barometer and a good observing mercurial-barometer, besides reserve barometers and aneroids.

10. The barometers must be verified by a Central Meteorological Office, and the observing barometer must be compared at least every week once with standard barometer.

11. Humidity. The psychrometer and the hair hygrometer are to be used, but at low temperatures they must be compared as often as possible with instruments for direct observation.

12. Wind. The vane and Robinson's anemometer should be arranged to be read off inside the observatory (*vide* the arrangement of the Swedish instruments at Spitzbergen). The direction of the wind is to be given for every 16 points and according to true bearings. Its velocity should always be given according to Robinson's anemometer, and also estimated Beaufort's scale. As a reserve instrument for measuring the wind force, in case of injury to Robinson's anemometer, Hagemann's anemometer recommended itself as being simple in management and very strong.

13. Clouds. Form, amount, and direction of motion at various heights, are to be observed to 16 points.

14. Rainfall, &c. Occurrence and duration of rain, snow *Graupel* (soft hail) are to be noted, and when possible the amount.

15. Weather. Thunderstorms, hail, fog, hoar-frost, and optical phenomena are also to be noted.

e. Observations of Terrestrial Magnetism

16. In determination of absolute declination and inclination the accuracy of one minute is to be aimed at, and in those of the absolute horizontal intensity accuracy of 0,001 of its value.

17. It is decidedly necessary, besides the absolute observations in the observatory itself, to make a series of measurements in its neighbourhood, in order to prove the existence of possible local influences.

18. The absolute observations must be conducted in the closest connection and synchronously with the readings of the variation instruments, so as to render it possible to reduce the indications of the latter to absolute value of determination, *e.g.* the absolute zero points of the different scales. The determinations must be made so frequently that any changes which may occur in the absolute value of the zero point of the scale of the variation apparatus may be detected with the requisite accuracy.

19. The observation of the variations should be extended to all three elements of terrestrial magnetism, and it is desirable that every station should have a complete duplicate system of variation instruments so as to make comparative observations from time to time, and to avoid the risk of the interruption of the observations by any accident.

20. The variation instruments should have small needles and the variation of horizontal intensity should be observed at least on one system with the unifilar apparatus with reflectors. Owing to the serious disturbances which may be expected, the scales of the variation instruments should be extended to at least 5° on each side, and as in certain cases deviations may even exceed these limits, the observers must be prepared to be able to measure even such greater excursions. The apparatus should be erected so as to facilitate as far as possible simultaneity of the observations.

21. During the whole time the variations should be read hourly. It is desirable that two readings should be made with an interval of a few minutes, for instance, before and after the exact hour.

22. As term days the first and fifteenth day of each month are fixed (only January 2 instead of 1 is taken); the days are from midnight to midnight, Göttingen time (mean civil time). The readings are to be made every five minutes, and always at the exact minute, and the three elements should be read as quickly as possible one after the other in the following order:—

Horizontal Intensity—Declination—Vertical Intensity.

23. On such term days during a whole hour, observations every twenty seconds are to be made, but only of the declination. These increased observations for one hour for the different term days are given in the following table:—

			Göttingen Civil Time.
1882,	August	1	12— 1 p.m.
		15	1— 2 ,,
	September	1	2— 3 ,,
		15	3— 4 ,,
	October	1	4— 5 ,,
		15	5— 6 ,,
	November	1	6— 7 ,,
		15	7— 8 ,,
	December	1	8— 9 ,,
		15	9—10 ,,
1883,	January	2	10—11 ,,
		15	11— Midn.
	February	1	12— 1 a.m.
		15	1— 2 ,,
	March	1	2— 3 ,,
		15	3— 4 ,,
	April	1	4— 5 ,,
		15	5— 6 ,,
	May	1	6— 7 ,,
		15	7— 8 ,,
	June	1	8— 9 ,,
		15	9—10 ,,
	July	1	10—11 ,,
		15	11— Noon.
	August	1	12— 1 p.m.
		15	1— 2 ,,

f. Auroral Observations

24. The auroras to be observed hourly with regard to shape, colour, and motion; the position to be given according to true bearings. The brilliancy of the different parts is to be estimated according to the scale 0—4 (vide Weyprecht: "Instructions for the Observation of Aurora, 1881"). In general, illumination of the aurora is sufficient to read printed matter; its brilliancy is to be estimated in this way and by the method employed in testing eyesight (as, for instance, according to the scale of Jaeger in Vienna).

25. On the term-days, continuous auroral observations will be carried out.

26. Especially remarkable instances of auroras and magnetic disturbances must be made the subject of special investigations, in order to render it possible to determine the connection of the variations of the phases of these two phenomena.

g. Astronomical Observations

27. As as much simultaneity as possible is a main object of the observations, determinations of position and time are to be carried out by instruments erected solidly (universal instrument, transit instrument, &c.), but these are not to exclude the use of good reflecting instruments. Every effort should be made as as quickly as possible to determine the longitude of the place with sufficient accuracy for the objects of expedition.

II. The Optional Observations

28. The Conference recommends the following observations and inquiries to the notice of all gentlemen who have either to draw up instructions for an expedition, or themselves to take part in one.

29. Meteorology. The variation of temperature with height; the temperature of the soil, the snow, and the ice on the surface and at various depths; solar radiation; evaporation at all seasons. The melting of ice in the summer.

30. Terrestrtal magnetism. Occasional absolutely simultaneous readings of all three magnetical instruments, so as to determine accurately the relation between the simultaneous variations of horizontal and vertical intensity.

31. Galvanic earth currents. Observations of earth-currents in close connection with magnetic observations and those of auroral phenomena.

32. Hydrographical observations. Observations on currents, on the thickness, structure, and motion of ice, soundings and observations on the physical properties of sea-water, *e.g.* determinations of its temperature and specific gravity. Tidal observations if possible by means of automatic apparatus.

33. Aurora. Measurements of the height of the aurora by two observers stationed about 5 kilometres (3 miles) apart in the line of the magnetic meridian—spectroscopical observations.

34. Observations on atmospheric electricity; on astronomical and terrestrial refraction; on twilight; on the length of the second's pendulum; on the growth and structure of floating ice and of glaciers. The collection of samples of air for analysis.—Observations and collections in the departments of zoology, botany, geology, &c.

III. The Reductions and Calculations at the Place of Observation

35. The rules adopted by the Congresses of Vienna and Rome are to be followed in all calculations and reductions of meteorological observations.

36. As regards the discussions of magnetic observations the adoption of the metrical units of Gauss is recommended. From the variation observations, the declination, and the horizontal and vertical components of the intensity are to be deduced.

IV.—Publication of the Observations

37. Summaries of the observations are to be sent to the International Polar Commis ion, as soon as possible after the return of the expedition, so as to be published speedily and in a uniform manner. It is desirable, if possible, to send even earlier notices of the fate and general progress of the expedition.

38. All observations are to be published *in extenso* when their discussion is complete. The International Polar Commission will therefore be reassembled for a fresh Conference, to learn the amount of information which has been obtained, and to come to an agreement as to the best mode of its publication.

39. In this publication the Metric scale will be used, and all temperatures expressed on the centigrade scale.

Nothing could be more complete and satisfactory than this programme, and from the results when reduced and carefully compared, valuable data may be expected as to the physics of the Arctic regions. We trust nothing will occur to mar the success and continuity of the observations, and that they will be such as to encourage their continuance, for we fear that a single year's observations cannot be regarded as furnishing anything like sufficient data to warrant perfectly trustworthy conclusions. The Commission very wisely decided that it would be advisable to obtain series of observations at existing observatories outside the Arctic Area, but as far as possible in the northern hemisphere. To their Circular on this subject they have received favourable answers from the following astronomical and meteorological observatories:—Pola, Munich, Utrecht, Moncalieri, Helsingfors, Breslau, Cordoba (South America), Potsdam, Naples, Lisbon, and Stonyhurst.

At the last moment, the English Government, although they sent no delegate to the Congresses, have decided, we are glad to say, to take a share in the great international undertaking. The following then is a list of the stations, beginning at Behring Strait, and coming eastwards, with the countries whose parties are to occupy them:—

Point Barrow, N.W. Coast Alaska. 71° 18′ N., 156° 24′ W. United States.
Fort Rae, Great Slave Lake. 62° 30′ N., 115° 40′ W. England and Canada.
Cumberland Sound, Davis Strait. 66° 30′ N., 66° W. Germany.
Lady Franklin Bay, N.E. Coast Grinnell Land. 81° 20′ N., 64° 58′ W. United States.
Godthaab, W. Coast of Greenland. 64° 10′ N., 51° 45′. Denmark.
Jan Mayen Island, between Greenland and Norway. 70° 58′ N., 8° 35′ W. Austria.
Spitzbergen. 79° 53′ N., 16° E. Sweden.
Bossekop, N. Coast Norway. 69° 56′ N., 23° E. Norway.
Sodankylä, N. Finland. 67° 24′ N., 26° 36′ E. Finland.
Novaya Zemlya, Karmakulé Bay. 72° 30′ N., 53° E. Russia.
Dickson's Harbour, Mouth of Jenissei. 73° 30′ N., 82° E. Holland.
Mouth of Lena. 73° N., 124° 40′ E. Russia.

Besides these France will carry on observations at Cape Horn, and Germany at South Georgia, on the borders of the Antarctic area; while, on behalf of Italy, Lieut. Bové is co-operating in the Italian Antarctic Expedition.

THE LAY OF THE LAST VORTEX-ATOM

(*Vide* "The Unseen Universe")

Melody—*Lorelei*

The Vortex-Atom was dying
  The last of his shivering race—
With lessening energy flying
  Through the vanishing realms of Space.

No more could he measure his fleeting—
  No milestones to mark out his way;
But he knew by his evident heating
  His motion was prone to decay.

So he stayed in his drift rectilinear
  For Time had nigh ceased to exist,
And his motion grew ever less spinnier
  Till he scattered in infinite mist.

But as his last knot was dissolving
  Into the absolute nought—
"No more," so sighed he resolving,
  "Shall I as atom be caught.

"I've capered and whirled for ages,
  "I've danced to the music of spheres,
"I've puzzled the brains of the sages—
  "Whose lives were but reckoned by years.

"They thought that my days were unending,
  "But sadly mistaken were they;
"For, alas! my 'life-force' is expending
  "In asymptotic decay!"

Edinburgh University K.

OUR HEALTH RESORTS[1]

The Scottish Highlands

THE Highlands of Scotland have been rapidly rising in importance during recent years, as affording during the summer and autumn months the most desirable health resorts to professional and business men, as well as to invalids: the most varied scenery, unique as it is picturesque, to the tourist; and the most attractive pleasure-grounds to the sportsman. When it is considered how comparatively unknown to the general run of summer tourists and visitors are the climatic and scenic attractions of large portions of the Highlands, and how

[1] See vol. xxv. p. 155.

rapidly the means of transit is being developed, and of accommodation multiplied, it is evident that for some years to come this popularity will continue to grow. These great advantages and attractiveness are due to physical configuration and climate.

As regards climate, the two points to be specially considered are the rainfall and temperature. Of these the most varied, and apparently the most capricious, is the rainfall, which alone imparts to the Highlands very great diversity in its climates.

An annual rainfall of forty inches may be taken as the limit separating the dry climates of the East from the wet climates of the West Highlands. If a line be drawn from Perth to Cape Wrath, all parts of Scotland to the east of it have, roughly speaking, a rainfall not exceeding forty inches, whereas to westward of that line the annual rainfall exceeds that amount. Hence the Eastern Grampians, the Highlands between the Don and Moray Firth, and the Highlands of Eastern Perth, Eastern Inverness, Eastern Ross, Eastern Sutherland, and Caithness are characterised by climates which are comparatively dry, and therefore bracing.

A glance at the map will show that the whole of the Scottish Highlands is, with respect to the west-south-west winds, entirely unprotected by Ireland, and completely exposed to these vapour-laden winds of the Atlantic. Over the whole of Scotland to the south of the Forth and Clyde, which may be regarded as under the lee of Ireland, the average rainfall at no station exceeds 66 inches, with the single exception of Ettrick Pen Top, 2268 feet high, at which fourteen years' observations gave an annual average of 71 inches.

On the other hand, the Highlands to the north of the Clyde are fully open to the west-south-west winds of the Atlantic, and there accordingly the late summer and autumnal rains set in early and with great copiousness. Over an extensive tract resting, as it were, on a base line stretching from Dunoon to Balquhidder, and extending north-westward to beyond Dunvegan, in Skye, the annual rainfall is at least 80 inches. In this extensive region the heaviest rainfalls, and therefore wettest climates are met with in situations either inclosed among mountains of rugged grandeur, such as the districts about Lochs Coruisk, Hourn, and Shiel, or up and over such plateaux as that whence rise the Tay, Leven, Orchy, Aray, and Falloch. The spot of largest rainfall in Scotland, so far as known, is near the head of Glencroe, situated between Lochs Fyne and Long, the mean annual amount there being 128 inches. Surrounding in a somewhat irregular manner this wet district, and stretching northward along the watershed, as far as Loch Assynt, is another region of twice the extent over which the rainfall is from 60 to 80 inches. Again, on the east of this region, and between it and the line marking an annual rainfall of 40 inches, is an extensive tract stretching as far as Cape Wrath, which has a rainfall from 40 to 60 inches annually, and the same rainfall is found in Western Sutherland, a large portion of Western Ross, the whole of the Hebrides, and all islands to the south, the surfaces of which rise to no great height above the sea.

Reference has been made to the shelter afforded by Ireland in imparting a drier climate to places situated to the east-north-east of it. The same principle is seen in the influence of Skye and the Hebrides in bringing about the comparatively dry climate of Western Ross and Sutherland, the rainfall of which is from 15 to 20 inches less annually than in similar situations south of Skye, but unprotected from the rain-bringing winds of the Atlantic. Indeed of all places in the west situated to the north of the Crinan Canal, Western Ross and Sutherland enjoy the driest, most bracing, and most desirable climates.

This district has besides an additional advantage, which it possesses along with Skye and Western Inverness-shire during the prevalence of rain-bringing winds from the east. In the east of Scotland the heaviest rains are brought by winds from the east, which are not unfrequently accompanied with a downfall of 2 or 3 inches, or even on rare occasions of 4 inches of rain in a day. The worst and most persistent of these winds, which cause, perhaps, the most disagreeable weather of these climates, owing to the mixture of cold drizzle and rain they bring with them, seldom deposit any rain over the west coast to the north of the Crinan Canal, and over the west of Perthshire. Indeed, on such occasions the weather in the west is almost always marvellously fine, and once enjoyed can never be forgotten, skies of the utmost purity, beauty, and softness, a brilliancy and warmth in the sunshine, a deliciousness in the air, and lights, colouring, and shades towards evening, of such infinite variety and beauty as perhaps no other climate can match.

As regards temperature, the great attraction of the climate of the Scottish Highlands is its comparative coolness, and this coolness becomes, of course, all the greater, the higher we ascend above the sea. As compared with London, the summer temperature of Braemar, for example, during the months of July, August, September, and October, is respectively $8^\circ\cdot9$, $9^\circ\cdot0$, $9^\circ\cdot1$, and $7^\circ\cdot4$ lower. The evenings and the nights are proportionally colder than the days. This is the climate which is best adapted for active exercise on the hills and moors. The admirably bracing and other hygienic qualities of the air of places which have comparatively dry climates, and which are 700 feet and upwards above the sea, are everywhere recognised; and it is these qualities which give the upper districts of Deeside, Donside, and Speyside the finest summer climates anywhere to be found in the British islands, particularly for those whose systems require to be braced up for the work of the coming winter. No other district, at these heights and temperatures, which contribute so important an ingredient to the climatic conditions required, can be named, having at the same time accommodation necessary for the comfort of summer visitors, which has not a summer climate essentially wet. The climates of places 700 feet high and upwards in Wales, the Lake District, on the slopes of the Lead and Lowther Hills, and eminently the West Highlands, can only be described as wet in comparison with those of the upper districts of the Dee, Don, and Spey.

Many excellent summer climates, but of quite a different type, are to be found at somewhat lower levels. Among the best of these, omitting sea-side climates, may be named Pitlochrie, Blair Athol, Lairg, Banchory, Dunkeld, Crieff, and Inverleithen, together with Callander and Moffat, the last two, however, being decidedly wetter. The important point to be attended to in selecting summer quarters in the Scottish Highlands is the rainfall, which is really the element of weather on which differences of climate depend; and attention to this point is all the more necessary, since in not a few cases a dry climate and a wet climate are to be found at comparatively short distances from each other.

ON "GETTING" COAL BY MEANS OF CAUSTIC LIME

THE operation of "getting" or breaking down coal from its original position in a seam cannot, in some cases, be effected with a sufficient degree of economy without the aid of blasting. But a certain amount of risk always attends the use of explosive substances, when they are employed for this purpose in fiery mines which are at the same time dry and dusty, unless certain precautions are taken which do not yet appear to be either generally observed or enforced by law. The existence of this danger has long been known, although its causes are only now beginning to be understood; and inventors have

been trying to discover some other method of arriving at the same end without producing flame.

Amongst these may be mentioned in this place:—

1. Improvements in wedging processes. A long iron wedge, placed in a previously drilled bore-hole between two strips of iron with flat faces and convex backs, is forced inwards by means of a screw or by hydraulic pressure.

2. Improvements in blasting processes. (*a*) A gunpowder cartridge is placed in an ordinary bore-hole, but a cylinder filled with water occupies most of the remainder of the hole instead of the usual tamping of rubbish (MacNab's Patent). (*b*) A dynamite cartridge inclosed in a waterproof bag is placed *in the interior of the water cylinder* of the last case (Abel's modification).

(The writer conducted a long series of experiments with dynamite water-cartridges for Prof. Abel and the Commissioners on Accidents in Mines, and the results will doubtless be published for the benefit of other investigators. In these experiments the mouth of the shot-hole was always situated in the centre of one side of a cubical bag containing 64 cubic feet of explosive gas.)

3. The caustic lime process, which forms the principal subject of the present note.

Although the proposal to employ caustic lime in this manner is not quite new, its first successful application has been made by Messrs. Smith and Moore, at Shipley Collieries in Derbyshire, where, thanks to the courtesy of these gentlemen, we lately saw it in operation under the superintendence of one of them. The seam of coal which is known as the Derbyshire Deep Hard, consists of three beds in immediate contact with each other. The top bed—one foot thick—is of inferior quality, and is left for a roof and permanently lost. The middle bed—2 feet 10 inches thick—produces good marketable coal in large blocks, and constitutes the object of working. The bottom bed—7 inches thick—together with a bed of soft shale 10 inches thick, serves as a holing. The method of working is longwall—the faces being straight, and each about 100 yards long. The holing is carried in to a depth of about 3½ or 4 feet under the coal; and while it is being done, the front of the mass which it is intended to detach is supported upon short timber props (*sprags*) placed at distances of six feet apart.

After the holing is completed a series of horizontal holes three inches in diameter are drilled close to the roof to a depth of three feet or so. These holes are also about six feet apart. Seven cylindrical blocks of caustic lime, each 2½ inches in diameter by 4¼ inches long are placed in each hole. They are prepared by grinding burnt lime to a powder, and then compressing it into blocks of the required shape and dimensions under a hydraulic press. They are, naturally, kept and carried in air-tight boxes. There is a groove in each block parallel with its axis, and large enough to receive a pipe ½ inch in diameter. The grooves are kept uppermost in the bore-hole. An iron pipe ½ inch in diameter, a few inches longer than the length of the hole, provided with a stop-cock at its outer end, and with a cloth bag drawn over its inner end, is inserted into the groove of the first block and then forms a guide for the others. Outside the last block the hole is firmly tamped first with paper, and then with rubbish.

After all the holes have been charged, a quantity of water, said to be equal in bulk to that of the caustic lime already occupying the hole, is forced into each in succession through the iron pipe. This is done by means of a hand-pump attached to a bucket, and provided with a short length of flexible hose. The stopcock of each pipe is immediately closed after the water has been introduced. This operation occupies about one minute for each hole, and the two men who carry it out pass along the face from one end to the other.

A sound as of steam escaping under a high pressure is now heard, and here and there the tamping is blown out. Then follows the well-known sound of what is technically called "working" while the coal is being separated from the upper bed by the pressure of the expanding lime. After the lapse of a few minutes it is found that the whole mass of coal is resting upon the sprags, and these have only to be knocked out in order that it may fall in the face.

The time required for the various operations may be divided as follows:—Drilling, 12 minutes; charging, 4 minutes; introducing water, 1 minute; total, 17 minutes for each bore-hole.

Although this system is undoubtedly successful in the circumstances under which it has been applied, it would be a mistake to assume that it is likely to have anything but a limited application. For it has been found by experiment to be incapable of breaking down a hard rock or shale roof, such as is to be met with in many mines in which blasting is required for that purpose, and for that alone.

Let us take the case of Risca Colliery, so notorious for great explosions, in which the roof of the roadways requires to be ripped down in order to get sufficient height for haulage purposes. The last great explosion took place at the beginning of the present year: but, as only the four men who were underground at the time were killed, it passed almost without remark. Nevertheless, the damage done by it was immense; coal-getting operations had to be suspended for over a month, and one large district of workings was entirely wrecked and was permanently abandoned.

And what were the circumstances under which all thi took place? Four men were firing four shots *in the principal intake air-way in the presence of dry coal-dust.* One of these shots blew out its tamping. The men were all found in the intake air-way with their safety-lamps uninjured.

This is a case which the objectors to the coal-dust theory both in this country and abroad would do well to ponder carefully. WILLIAM GALLOWAY

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA

I.

General Law of Progressive Modification

PETALS are in all probability originally enlarged and flattened stamens, which have been set apart for the special work of attracting insects. It seems likely that all flowers at first consisted of the central organs alone—that is to say, of a pistil, which contains the ovary with its embryo seeds; and of a few stamens, which produce the pollen. But in those plants which took to fertilisation by means of insects—or, one ought rather to say, in those plants which insects took to visiting for the sake of their honey or pollen, and so unconsciously fertilising—the flowers soon began to produce an outer row of barren and specialised stamens, adapted by their size and colour for attracting the fertilising insects; and these barren and specialised stamens are what we commonly call petals.

As the stamens of almost all flowers, certainly of all the oldest and simplest flowers, are yellow, it would seem naturally to follow that the earliest petals would be yellow too. When the stamens of the outer row were flattened and broadened into petals, there would be no particular reason why they should change their colour; and, in the absence of any good reason, they doubtless retained it as before. Indeed, the earliest and simplest types of existing flowers are almost always yellow, seldom white, and never blue; and this in itself would be sufficient ground for believing that yellow was the original colour of all petals. But as it is somewhat heretical to believe, contrary to the general run of existing scientific opinion, that petals are derived from flattened stamens, instead of from simplified and attenuated leaves, it may be well to detail here

the reasons for this belief. For if the petals were originally a row of altered stamens set apart for the special function of attracting insects, it would be natural and obvious why they should begin by being yellow; but if they were originally a set of leaves, which became thinner and more brightly coloured for the same purpose, it would be difficult to see why they should first have assumed any one colour rather than another.

The accepted doctrine as to the nature of petals is that

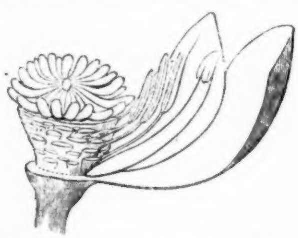


FIG. 1.—Transition from stamens to petals in the white water lily.

discovered by Wolf and subsequently rediscovered by Goethe, who held that all the parts of the flower were really modified leaves, and that a gradual transition could be traced between them, from the ordinary leaf, through the stem-leaf and the bract, to the sepal, the petal, the stamen, and the carpel. Now, if we look at most modern flowers, such a transition can undoubtedly be observed; and sometimes it is very delicately graduated, so

FIG. 2.—Transition from stamen (*a*) to petal (*b*) and sepal (*c*) in flower of double rose.

that you can hardly say where each sort of leaf merges into the next. But, unfortunately for the truth of the theory as ordinarily understood, we now know that in the earliest flowers there were no petals or sepals, but that primitive flowering plants had simply leaves on the one hand, and stamens and ovules on the other. The oldest types of flowers at present surviving, are certain gymnosperms, such as the cycads, of which the well-known

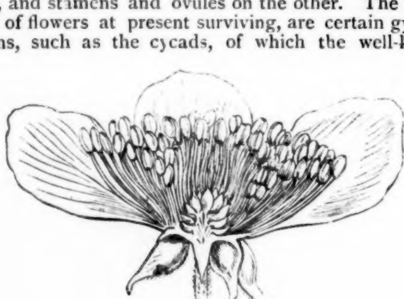


FIG. 3.—Vertical section of bramble (white).

Zamias of our conservatories may be regarded as good examples. These have only naked ovules on the one hand, and clusters of stamens in a sort of cone on the other. The gymnosperms are geologically earlier than any other flowering plants. But, if petals and sepals are later in origin than stamens and carpels, we can hardly say that they mark the transition from one form to the other, any more than we can say that Gothic architecture marks the transition from the Egyptian style to the classical Greek. It is not denied, indeed, that the stamen and the ovary are themselves by origin modified leaves—that part of the Wolfian theory is absolutely irrefutable—but with the light shed upon the subject by the modern doctrine of evolution, we can no longer regard petals and sepals as intermediate stages between the two. The earliest flowering plants had true leaves on the one hand,

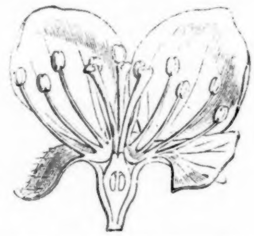


FIG. 4.—Vertical section of apple blossom (pinky white).

and specialised pollen-bearing or ovule-bearing leaves on the other hand, which latter are what in their developed forms we call stamens and carpels; but they certainly had no petals at all, and the petals of modern flowers have been produced at some later period.

All stamens show a great tendency easily to become petaloid, that is to say, to flatten out their filament, and finally to lose their anthers. In the waterlilies we can

FIG. 5.—Vertical section of dog-rose (bright pink).

trace a regular gradation from the perfect stamen to the perfect petal. Take for example our common English white *Nymphæa alba* (Fig. 1). In the centre of the flower we find stamens of the ordinary sort, with rounded filaments, and long yellow anthers; then, as we move outward, we find the filaments growing flatter and broader, and the anthers less and less perfect; next we find a few stamens which look exactly like petals, only that they have two abortive

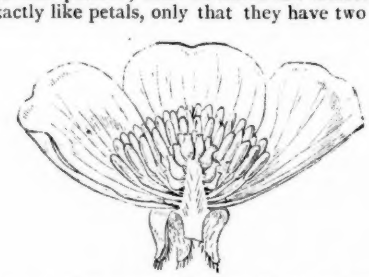


FIG. 6.—Vertical section of buttercup (primitive yellow).

anthers stuck awkwardly on to their summits; and, finally, we find true petals, broad and flat, and without any trace of the anthers at all. Here in this very ancient though largely modified flower we have stereotyped for us, as it were, the mode in which stamens first developed into petals, under stress of insect selection.

"But how do we know," it may be asked, "that the

transition was not in the opposite direction? How do we know that the waterlily had not petals alone to start with, and that these did not afterwards develop, as the Wolfian hypothesis would have us believe, into stamens?" For a very simple reason. The theory of Wolf and Goethe is quite incompatible with the doctrine of development, at least if accepted as a historical explanation (which Wolf and Goethe of course never meant it to be). Flowers can

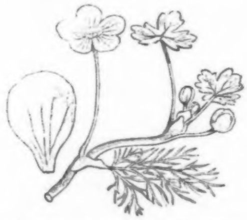


FIG. 7.—Water crowfoot (white with yellow centre).

and do exist without petals, which are no essential part of the organism, but a mere set of attractive coloured advertisements for alluring insects; but no flower can possibly exist without stamens, which are one of the two essential reproductive organs in the plant.

Indeed, if we examine closely the waterlily petals, it is really quite impossible to conceive of the transition as taking place from petals to stamens, instead of from stamens to petals. It is quite easy to understand how the

FIG. 8.—Columbine (bluish purple).

filament of an active stamen may become gradually flattened, and the anthers progressively void and functionless; but it is very difficult to understand how or why a petal should first begin to develop an abortive anther, and then a partially effective anther, and at last a perfect stamen. The one change is comprehensible and reasonable, the other change is meaningless and absurd.

In many other cases besides the waterlily, we know that stamens often turn into petals. Thus the numerous coloured rays of the *Mesembryanthemums* are acknowledged by many botanists to be flattened stamens. In *Canna*, where one anther-cell is abortive, the filament of the solitary stamen becomes petaloid. In the ginger order, one outer whorl of stamens resembles the tubular

FIG. 9.

FIG. 10.

FIG. 9.—Petal of columbine, secreting honey in its spur. FIG. 10.—Monkshood (deep blue).

corolla, so that the perianth seems to consist of nine lobes instead of six. In orchids, according to Mr. Darwin, the lip consists of one petal and two petaloid stamens of the outer whorl. In double roses (Fig. 2) and almost all other double flowers the extra petals are produced from the stamens of the interior. In short, stamens generally can be

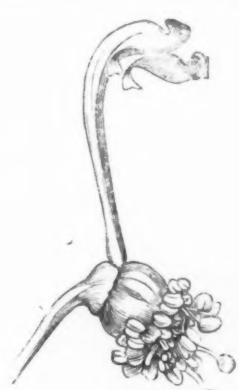


FIG. 11.—Petals of monkshood modified into nectaries.

readily converted into petals, especially in rich and fertile soils or under cultivation. The change is extremely common in the families of *Ranunculaceæ*, *Papaveraceæ*, *Magnoliaceæ*, *Malvaceæ*, and *Rosaceæ*, all very simple types. Looking at the question as a whole, we can see how petals might easily have taken their origin from stamens,

while it is difficult to understand how they could have taken their origin from ordinary leaves—a process of which, if it ever took place, no hint now remains to us.

In a few rare instances, petals even now show a slight tendency to revert to the condition of fertile stamens. In *Monandra fistulosa* the lower lip is sometimes prolonged into a filament bearing an anther: and the petals of shepherd's-purse (*Capsella bursa-pastoris*) have been observed antheriferous.

But if the earliest petals were derived from flattened stamens, it would naturally follow that they would be for the most part yellow in colour, like the stamens from which they took their origin. How, then, did some of them afterwards come to be white, orange, red, purple, lilac, or blue?

The different hues assumed by petals are all, as it were, laid up beforehand in the tissues of the plant, ready to be brought out at a moment's notice. And all flowers, as we know, easily sport a little in colour. But the question is, do their changes tend to follow any regular and definite order? Is there any reason to believe that the modification runs from any one colour towards any other? Apparently, there is. All flowers, it would seem, were in their earliest form yellow; then some of them became white; after that, a few of them grew to be red or purple; and, finally, a comparatively small number acquired various shades of lilac, mauve, violet, or blue.

Some hints of a progressive law in the direction of a colour-change from yellow to blue are sometimes afforded us even by the successive stages of a single flower. For example, one of our common little English forget-me-nots, *Myosotis versicolor*, is pale yellow when it first opens; but as it grows older, it becomes faintly pinkish, and ends by being blue like the others of its race. Now, this sort of colour-change is by no means uncommon; and in almost all known cases it is always in the same direction, from yellow or white, through pink, orange, or red, to purple or blue. Thus, one of the wall-flowers, *Cheiranthus chamæleo*, has at first a whitish flower, then a citron-yellow, and finally emerges into red or violet. The petals of *Stylidium fruticosum* are pale yellow to begin with, and afterwards become light rose-coloured. An evening primrose, *Œnothera tetraptera*, has white flowers in its first stage, and red ones at a later period of development. *Cobæa scandens* goes from white to violet; *Hibiscus mutabilis* from white through flesh-coloured, to red. The common Virginia stock of our gardens (*Malcolmia*) often opens of a pale yellowish green; then becomes faintly pink; afterwards deepens into bright red; and fades away at last into mauve or blue. Fritz Müller noticed in South America a *Lantana*, which is yellow on its first day, orange on the second, and purple on the third. The whole family of *Boraginaceæ* begin by being pink, and end by being blue. In all these and many other cases the general direction of the changes is the same. They are usually set down as due to varying degrees of oxidation in the pigmentary matter.

If this be so, there is a good reason why bees should be specially fond of blue, and why blue flowers should be specially adapted for fertilisation by their aid. For bees and butterflies are the most highly adapted of all insects to honey-seeking and flower-feeding. They have themselves on their side undergone the largest amount of specialisation for that particular function. And if the more specialised and modified flowers, which gradually fitted their forms and the position of their honey-glands to the forms of the bees or butterflies, showed a natural tendency to pass from yellow through pink and red to purple and blue, it would follow that the insects which were being evolved side by side with them, and which were aiding at the same time in their evolution, would grow to recognise these developed colours as the visible symbols of those flowers from which they could obtain the largest amount of honey with the least possible trouble. Thus it would finally result that the ordinary unspecialised flowers, which depended upon small insect riff-raff, would be mostly left yellow or white; those which appealed to rather higher insects would become pink or red; and those which laid themselves out for bees and butterflies would grow for the most part to be purple or blue.

Now, this is very much what we actually find to be the case in nature. The simplest and earliest flowers are those with regular, symmetrical open cups, like the *Ranunculus* genus, the *Potentillas*, and the *Alsineæ* or chickweeds, which can be visited by any insects whatsoever: and these are in large part yellow or white. A little higher are flowers, like the campions or *Sileneæ*, and the stocks (*Matthiola*), with more or less closed cups, whose honey can only be reached by more specialised insects; and these are oftener pink or reddish. More profoundly modified are those irregular one-sided flowers, like the violets, peas, and orchids, which have assumed special shapes to accommodate bees or other specific honey-seekers; aud these are often purple and not infrequently blue. Highly specialised in another way are the flowers like harebells (*Campanula*), scabious (*Dipsaceæ*). and heaths (*Ericaceæ*), whose petals have all coalesced into a tubular corolla; and these might almost be said to be usually purple or blue. And, finally, highest of all are the flowers, like labiates (rosemary, *Salvia*, &c.) and speedwells (*Veronica*,) whose tubular corolla has been turned to one side, thus combining the united petals with the irregular shape; and these are almost invariably purple or blue.

The very earliest types of angiospermous flowers now remaining are those in which the carpels still exist in a separate form, instead of being united into a single compound ovary. Among Dicotyledons, the families, some of whose members best represent this primitive stage, are the *Rosaceæ* and *Ranunculaceæ*; among Monocotyledons, the *Alismaceæ*. We may conveniently begin with the first group.

The roses form a most instructive family. As a whole they are not very highly developed flowers, since all of them have simple, open, symmetrical blossoms, generally with five distinct petals. But of all the rose tribe, the *Potentilleæ*, or cinquefoil group, seem to make up the most central, simple, and primitive members. They are simple low, creeping weeds, and their flowers are of the earliest symmetrical pattern, without any specialisation of form, or any peculiar adaptation to insect visitors. Now among the potentilla group, nearly all the blossoms have yellow petals, and also the filaments of the stamens yellow, as is likewise the case with the other early allied forms, such as agrimony (*Agrimonia Eupatoria*), and herb-bennet (*Geum urbanum*). Among our common yellow species are *Potentilla reptans* (cinquefoil), *P. tormentilla*, *P. argentea*, *P. verna*, *P. fruticosa*, and *P. anserina*. Almost the only white potentillas in England are the barren strawberry (*P. fragariastrum*), and the true strawberry (*Fragaria vesca*), which have, in many ways, diverged more than any other species from the norma of the race. Water-avens (*Geum rivale*), however, a close relative of herb-bennet, has a dusky purplish tinge; and Sir John Lubbock notes that it secretes honey, and is far oftener visited by insects than its kinsman. The bramble tribe (*Rubeæ*), including the blackberry (Fig. 3), raspberry, and dewberry, have much larger flowers than the potentillas, and are very greatly frequented by winged visitors. Their petals are usually pure white, often with a pinky tinge, especially on big, well-grown blossoms. One step higher, the cherries and apples (though genetically unconnected), have very large and expanded petals (Fig. 4), white toward the centre, but blushing at the edges into rosy pink or bright red. Finally, the true roses (Fig. 5), whose flowers are the most developed of all, have usually broad pink petals (like those of our own

dog-rose, *Rosa canina, R. villosa, R. rubiginosa,* &c.), which in some still bigger exotic species become crimson or damask of the deepest dye. They are more sought after by insects than any others of their family.

Now, if we look closely at these facts we see that they have several interesting implications. The yellow potentillas have the very simplest arrangement of the carpels in the whole family, and their fruit is of the most primitive character, consisting only of little dry separate nuts. They have altered very little from their primitive type. Accordingly almost all the genus is yellow; a very few members only are white; and these in their habits so far vary from the rest that they have very erect flowers, and three leaflets instead of five or more to each leaf. One of them, the strawberry, shows still further marks of special differentiation, in that it has acquired a soft, pulpy, red fruit, produced by the swelling of the receptacle, and adapted to a safer mode of dispersal by the aid of birds. This group, however, including *Geum,* cannot claim to be considered the earliest ancestral form of the roses, because of its double calyx, which is not shared by other members of the family, as it would be if it had belonged to the actual common ancestor. In that respect, agrimony more nearly represents the primitive form, though its tall habit and large spikes of flowers show that it also has undergone a good deal of modification. Nevertheless, the yellow members of the potentilla group, in their low creeping habit, their want of woodiness, and their simple fruit, certainly remain very nearly at the primitive ancestral stage, and may be regarded as very early types of flowers indeed. It is only among handsome and showy exotic forms which have undergone a good deal more modification, that we get brilliant red-flowered species like the East Indian *P. nepalensis* and *P. atropurpurea.*

But as soon as the plants rise a little in the scale, and the flowers grow larger, we get a general tendency towards white and pink blossoms. Thus the *Pruneæ* have diverged from the central stock of the rose family in one direction, and the *Pomeæ* and *Roseæ* in another; but both alike begin at once to assume white petals; and as they lay themselves out more and more distinctly for insect aid, the white passes gradually into pink and rose colour. To trace the gradations throughout, we see that the *Rubeæ* or brambles are for the most part woody shrubs instead of being mere green herbs, and they have almost all whitish blossoms instead of yellow ones; but their carpels still remain quite distinct, and they seldom rise to the third stage of pinkiness; when they do, it is generally just as they are fading, and we may lay it down as a common principle that the fading colours of less developed petals often answer to the normal colours of more developed. In the *Pruneæ,* again, the development has gone much further, for here most of the species are trees or hard shrubs, and the number of carpels is reduced to one. They have a succulent fruit—a drupe, the highest type—and though the flower contains two ovules, the ripe plum has only one seed, the other having become abortive. All these are marks of high evolution: indeed, in most respects the *Pruneæ* stand at the very head of the rose family, but the petals are seldom very expanded, and so, though they are usually deeply tinged with pink in the cherry (*Prunus cerasus*), and still more so in larger exotic blossoms, like the almond, the peach, and the nectarine, they seldom reach the stage of red. Our own sloe (*P. communis*) has smallish white flowers, as has also the Portugal laurel (*P. lusitanicus*). In these plants, in fact, higher development has not largely taken the direction of increased attraction for insect fertilisers; it has mainly concentrated itself upon the fruit, and the devices for its its dispersal by birds or mammals. In the *Roseæ,* on the other hand, though the fruit is less highly modified, the methods for insuring insect fertilisation are carried much further. There are several carpels, but they are inclosed within the tube of the calyx, and the petals are very much enlarged indeed, while in some species the styles are united in a column. As regards insect attraction, indeed, the roses are the most advanced members of the family, and it is here accordingly that we get the highest types of coloration, Most of them are at least pink, and many are deep red or crimson. Among the *Pomeæ* we find an intermediate type (as regards the flowers alone) between *Roseæ* and *Pruneæ;* the petals are usually bigger and pinker than those of the plums; not so big or so pink as those of the true roses. This interesting series exhibits very beautifully the importance as regards coloration of mere expansion in the petals. Taking them as a whole, we may say that the smallest petals in the rose family are generally yellow; the next in size are generally white; the third in order are generally pink; and the largest are generally rose-coloured or crimson.

Even more primitive in type than the *Rosaceæ* are the lowest members of the *Ranunculaceæ,* or buttercup family, which perhaps best of all preserve for us the original features of the early dicotyledonous flowers. The family is also more interesting than that of the roses, because it contains greater diversities of development, and accordingly covers a wider range of colour, its petals varying from yellow to every shade of crimson, purple, and blue. The simplest and least differentiated members of the group are the common meadow buttercups, forming the genus *Ranunculus* (Fig. 6), which, as everybody knows, have five open petals of a brilliant golden hue. Nowhere else is the exact accordance in tint between stamens and petals more noticeable than in these flowers. The colour of the filaments is exactly the same as that of the petals; and the latter are simply the former a little expanded and deprived of their anthers. We have several English meadow species, all with separate carpels, and all very primitive in organisation, such as *R. acris* (the central form), *R. bulbosus, R. repens, R. flammula, R. sceleratus, R. auricomus, R. philonotis,* &c. In the lesser celandine or pilewort, *R. ficaria,* there is a slight divergence from the ordinary habit of the genus, in that the petals, instead of being five in number, are eight or nine, while the sepals are only three; and this divergence is accompanied by two slight variations in colour: the outside of the petals tends to become slightly coppery, and the flowers fade white, much more distinctly than in most other species of the genus.

There are two kinds of buttercup in England, however, which show us the transition from yellow to white actually taking place under our very eyes. These are the water-crowfoot, *R. aquatilis,* and its close ally, the ivy-leaved crowfoot, *R. hederaceus,* whose petals are still faintly yellow toward the centre, but fade away into primrose and white as they approach the edge (Fig. 7). We have already noticed that new colours usually appear at the outside, while the claw or base of the petal retains its original hue; and this law is strikingly illustrated in these two crowfoots. White flowers of the same type as those of water-crowfoot are very common among aquatic plants of like habit, and they seem to be especially adapted to water-side insects.

In many *Ranunculaceæ* there is a great tendency for the sepals to become petaloid, and this peculiarity is very marked in *Caltha palustris,* the marsh-marigold, which has no petals, but bright yellow sepals, so that it looks at first sight exactly like a very large buttercup.

The clematis and anemone, which are more highly developed, have white sepals (for the petals here also are suppressed), even in our English species; and exotic kinds varying from pink to purple are cultivated in our flower-gardens.

It is among the higher ranunculaceous plants, however, that we get the fullest and richest coloration. Columbines (*Aquilegia*). are very specialised forms of the buttercup type (Fig. 8). Both sepals and petals are brightly coloured, while the latter organs are produced above into

long, bow-shaped spurs, each of which secretes a drop of honey (Fig. 9). The carpels are also reduced to five, the regularity of number being itself a common mark of advance in organisation. Various columbines accordingly range from red to purple, and dark blue. Our English species, *A. vulgaris*, is blue or dull purple, though it readily reverts to white or red in cultivated varieties. Even the columbine, however, though so highly specialised, is not bilaterally but circularly symmetrical. This last and highest mode of adaptation to insect visits is found in larkspur (*Delphinium ajacis*), and still more developed in the curious monkshood (*Aconitum napellus*), Fig. 10. Now larkspur is usually blue, though white or red blossoms sometimes occur by reversion; while monkshood is one of the deepest blue flowers we possess. Both show very high marks of special adaptation; for besides their bilateral form, *Delphinium* has the number of carpels reduced to one, the calyx coloured and deeply spurred, and three of the petals abortive; while *Aconitum* has the carpels reduced to three and partially united into a compound ovary, the upper sepals altered into a curious coloured hood or helmet, and the petals considerbly modified. All these very complex arrangements are definitely correlated with the visits of insects, for the two highly abnormal petals under the helmet of the monkshood (Fig. 11) produce honey, as do also the two long petals within the spur of the larkspur. Both flowers are also specially adapted to the very highest class of insect visitors. *Aconitum* is chiefly fertilised by bees; and Sir John Lubbock observes that "*Anthophora pilipes* and *Bombus hortorum* are the only two North European insects which have a proboscis long enough to reach to the end of the spur of *Delphinium elatum*. *A. pilipes*, however, is a spring insect, and has already disappeared, before the *Delphinium* comes into flower, so that it appears to depend for its fertilisation entirely on *Bombus hortorum*."

(*To be continued.*)

FREDERIC KASTNER

FREDERIC KASTNER, who is known to the scientific world as the inventor of the *Pyrophone*, has recently died, as we announced at the time, at the early age of thirty years. He was the son of an Alsacian composer of some merit, Georges Kastner, and was himself an accomplished musician. Educated partly at Paris and partly at Strasburg, he imbibed a love of science, and at the early age of fourteen years was already assisting his teachers in the chemical laboratory. When seventeen years of age he invented and patented a novel form of electromotor, in which a series of electro-magnets were caused to act in succession upon a rotating arbor. After the war of 1870-71, in which he was driven from Strasburg, he devoted himself to studying the properties of musical flames. The discovery of Higgins in 1777, that a hydrogen flame burning within the lower end of an open glass tube could set up a musical note, had been the starting point of a number of hitherto barren attempts by Schaffgotsch and others. Without knowing anything of the experiments of Schaffgotsch, Barrett, or Tyndall, young Kastner set to work to experiment, with the determination to construct a musical instrument on this principle. For two years he worked at the subject, endeavouring to temper the harsh tones of the flames and to produce a purity and constancy in their notes. He tried tubes of different sizes and forms. He varied the form of the gas jet, and essayed to introduce two or more jets into one tube. At last, in 1871, he discovered that when he employed *two* flames he could control their note at will, being silent when both were close together, but producing sound when they were separated. This phenomenon, which Kastner called the interference of flames, was the real starting-point of Kastner's *Pyrophone* or *Flame-Organ*, which he patented in 1873. This organ had for its pipes glass tubes of different lengths, two hydrogen flames burning in each at the proper height. A very simple lever-arrangement served to separate the flames at will. In this form the instrument was presented to the Académie des Sciences at Paris, and publicly exhibited. Two subsequent improvements followed. A circle of small jets of common coal gas was found to answer quite as well as the two hydrogen jets, the circle being constructed so that by a simple mechanical contrivance it could be increased or diminished in size, thus separating or reuniting the flames at will. The second improvement was the application of electric currents and an electromagnetic apparatus enabling the flame-organ to be played at a distance. The first instrument of this kind constructed by Kastner was in the form of a singing-lustre hung from the chandelier in his mother's house. The pyrophone was shown at the Royal Institution in January, 1875, and at the Society of Arts in the succeeding month. It was also shown at the Loan Collection of Scientific apparatus at South Kensington in 1876, and at the Paris Exhibition in 1878. In 1876, moreover, an account of the instrument and of the researches which led to its construction was published by Kastner under the title of "Flammes Chantantes." The strange, weird tones produced by the instrument attracted the notice of musicians. Gounod sought to introduce the pyrophone into his opera of "Jeanne d'Arc," and Kœnemann at Baden Baden, in 1879, actually introduced the instrument on one occasion. A decline, however, seized the young inventor, whose strength for some years ebbed slowly away, and he died all too soon to see his invention fairly recognised by the public.

THE NEW AFRICAN EXPEDITION

IT is now understood to be quite settled that a new African exploring expedition will start next year. The Royal Geographical Society have, as might have been expected, taken the opportunity of Mr. Joseph Thomson's return from the completion of his engagement to the Sultan of Zanzibar to obtain his services as leader, and it is certain that no bettter selection could have been made.

Mr. Thomson will leave England in the Spring of 1883, and proceed to Zanzibar to organise the expedition. From Mombas, a port on the East African coast, to the north of Zanzibar, he will direct his course straight to Kilimandjaro, and do his best to explore the snowy ranges of this celebrated mountain, which but one European has as yet ever reached. Passing across the water-parting he will then descend through an entirely unknown country to the eastern shore of Lake Victoria Nyanza, and return to the coast by a more northern route, in the course of which it is hoped he may be able to visit Lake Baringo and Mount Kenia—another peak known to run far above the snow-level, but concerning which further details would be very desirable.

As a mere geographical expedition it will be thus seen that the proposed route will be one of great interest, embracing, as it does, the transit through much utterly unknown country, and the exploration of two mysterious snow-crowned mountains, which, according to the usual view of the conformation of the African Continent, appear to be quite out of place in the districts in which they are situated. But still more interesting problems will be solved, if steps are taken to investigate the unknown fauna and flora of Kilimandjaro and Kenia. The animal and vegetable life of these mountains must be entirely different from that of the plains by which they are surrounded. They will prove to have been derived either by modification from the adjacent lower districts, or by immigration from the north—in any case, presenting phenomena of first-rate importance to the student of geographical distribution.

While, however, the Society, which, with its habitual energy, has set on foot the proposed expedition, is ready and willing to do all that is necessary to ensure success in the way of geographical exploration, it does not consider itself bound to undertake the further outlay which the investigation of the natural history of Kilimandjaro and Kenia must necessarily require. To effect this in a satisfactory way, a zoologist and botanist should be attached to Mr. Thomson's staff to make the necessary observations and collections. These gentlemen might perhaps be best left on the upper ranges of Kilimandjaro, while Mr. Thomson descends to the shores of the Victoria Nyanza, to rejoin him on his return towards the sea-coast. However this may be arranged, it is obvious that the addition of two Europeans to the expedition and the transport of their collection from the interior cannot be effected without materially increasing the cost. It is hoped, therefore, that the British Association for the Advancement of Science, which has already been in correspondence with the Geographical Society upon the subject of the proposed expedition, will take up this branch of the question, and at the approaching meeting at Southampton supply the funds necessary for the purpose. It would be a great misfortune if the excellent opportunity of solving a problem of first-rate importance which thus presents itself were to be thrown away for want of the few hundred pounds required to send out naturalists in company with the proposed expedition.

NOTES

WE can only express, for the present, the deep regret with which we learn the death of Prof. F. M. Balfour, a regret which we are sure will be shared by all who know anything of Mr. Balfour's career. The details to hand of the accident which led to Mr. Balfour's death are meagre. The news reached Cambridge on Sunday evening that he had been killed by a fall on the Alps. From later information it would seem that both Mr. Balfour and his guide met with their deaths on the glacier of Fresney, on the south side of Mont Blanc, about five miles west of the village of Courmayeur. The bodies have both been found. Mr. Balfour was only thirty-one years of age.

MR. GEORGE P. MARSH, the venerable American Minister at Rome, whose death, at the age of eighty-one years, has just been announced, was known as the author of the interesting work on "The Earth as Modified by Human Action," reviewed in NATURE, vol. xi. p. 82. His well-known work on "The Origin and History of the English Language" is also marked by a true scientific spirit.

THE German Association of Naturalists and physicians meets this year at Eisenach, from September 18 to 21. In deference to the wishes of many members, the duration of the meeting has been shortened this year by curtailing the festivities which have hitherto held so large a place in the proceedings of this venerable association. The Association, however, will really begin its work on the Sunday evening (September 17) by a "Zusammenkunft im 'Tivoli,'" and finish on the Friday (22nd) by an excursion to Kissingen, the programme including lunch, dinner, supper, and ball. On the 18th, Prof. Haeckel will give a lecture "On the Interpretation of Nature by Darwin, Goethe, and Lamarck"; and on the 21st Prof. Rehmke lectures on "Physiology and Kantism." As the German Association meets quite a fortnight later than our own, there is nothing to hinder English men of science attending both. It is a pity some arrangement could not be come to among the various associations to prevent simultaneous meetings. The English, French, and American Associations all meet this year at the same time; the Americans, at least, might have arranged differently, seeing that their meeting in Montreal next month is intended to be to some extent international.

MR. W. A. FORBES, the Prosector of the Zoological Society of London, has just left the country upon a four month's expedition up the River Niger. During his absence Mr. W. N. Parker has been appointed Deputy Prosector to the Zoological Society. To him all communications should be addressed during Mr. Forbes's absence.

THE United States Government have voted 10,000*l*. for the International Fisheries Exhibition. From the statement made by the Prince of Wales at a meeting of the General Committee last week, it is evident that the arrangements are progressing favourably.

MR. EUGENE OATES, who has been collecting in Pegu for the last fourteen years, is now in England, and has been studying for some months at the British Museum, his intention being to issue shortly a revised catalogue of the birds of Burmah, for which task his personal experiences in the field point him out as being admirably fitted.

MR. WM DAVISON, who is so well known for his collections in Tenasserim and the Malay Peninsula, under the auspices of that energetic ornithologist, Mr. A. O. Hume, is also now in this country. We are glad to hear that Mr. Davison's health is fast becoming restored, and that he hopes soon to be able to return to the scene of his scientific explorations in Malaiasia.

VOL. I. of a large work on "Electric Illumination" will shortly be published at the office of *Engineering*. The volume refers to general principles, current generators, conductors, carbons, and lamps, the authors being Mr. Conrad W. Cooke, Mr. James Dredge, Prof. O'Reilly, Prof. Silvanus P. Thompson, and M. H. Vivarez; the whole will be edited by Mr. Dredge. A second volume will follow, to comprise installations, motive power, cost of production and maintenance, electrical photometry, secondary batteries, accessories to electric lighting, &c., &c., together with the completion of the patent abridgements from 1872 to 1882.

THE Algerian Government has sent to France a scientific mission to study the means of destroying the Phylloxera. It is mostly composed of viticulturists, apprehensive that the pest may eventually cross the Mediterranean.

"WHENCE comes the x of mathematicians?" is a question on which M. de Lagarde supplies some curious information (in a note to the Göttingen Royal Society of Sciences). The old Italian algebraists named the unknown quantity in an equation, *cosa*, or *res* (which they either wrote out or denoted by a sign). These are translations of the Arabic *šai*, thing, by which the Arabians in Spain indicated the unknown quantity—writing the Arabic equivalent of š; thus our $12x$ would be $\overset{\check{s}}{12}$. Now it has been the rule in Spain to express the Arabic š by the Latin x. Thus our mathematical x seems to have come from the Arabic for thing. Going further back, to the Greeks, it appears that Diophantus called the unknown quantity ἀριθμός; and for this, a final sigma, accented, came to be written. It is thought the Arabians may have denoted this by their š, and called it by the name for *thing*. The Greek name for the square of the unknown quantity was δύναμις, and for the cube κύβος; and the corresponding Arabian terms are clearly derived from these by translation; hence a probability of derivation in the other case (though not by translation).

WE lately noticed a full report on education in the United States, as delineated and reviewed by the Bureau. A later Circular (No. 6) calls special attention to the present teaching of physics and chemistry. The growth of science-teaching, it says, is evident everywhere; and how the movement will culminate, no one can say. To-day, chemistry and physics are

taught in nearly all the academies and high schools in the land. Few cities report no teaching; and this circular is an attempt to catch the present aspect of affairs, and to assist and guide them. The supply of science students from the training colleges is increasing fast, and the number of teachers able to give laboratory instruction will soon be equal to the demand. The teaching at some of the older colleges, where the accustomed routine of a classical education cannot be dropped, is among the least satisfactory. The newer schools recognise science as a mental gymnastics and training equal to "Euclid's Elements and the Latin Grammar," always insisting upon the importance of experiment with didactic instruction. In a great majority of cases, nevertheless, mere text-book work is done, and as such work is little else than mischievous cram, our report advises that it be left out in primary and intermediate schools. Far better so, than a long series of lectures listened to term after term; for "three months of laboratory *work* will give more real insight into any science than a whole year's study of the printed page; the latter is like learning language from a grammar, only without attempting to translate or write exercises." It is specially urged, therefore, that the experimenting be done *by the pupils*, and the excellent results of such teaching, even to the youngest learners, are shown in very interesting cases quoted; and the same principle is followed in recommending that apparatus should be extemporised—this also by the pupils especially. "It will be invaluable to the future teacher; it vastly increases his power to interest and instruct his pupils, and at the same time it deepens his own insight into the subjects taught" The value of physical and chemical knowledge to medical men, the inadequate training of many of whom in America we recently noticed, to naval officers, and to women, is specially indicated and enlarged upon. But any such appeal to practical motives is hardly necessary in America, for the complaint is also made that applied science is most in demand, while pure science and research are too commonly ignored.

AT the last meeting of the Anthropological Institute, held at 4, Grosvenor Gardens, the residence of the President, General Pitt-Rivers, F.R.S., who occupied the chair, Lord Talbot de Malahide read a paper on the Longevity of the Romans in North Africa. The author gave several instances of epitaphs and inscriptions on tombs of persons whose age had exceeded 100 years, in some cases an age of 120, 130, and even 140 years had been attained. An interesting discussion ensued in which Mr. Villiers Stuart, M.P., Mr. Moncure Conway, Capt. Cameron, Mr. John Evans, Mr. Francis Galton, Sir Joseph Fayrer, Dr. Allen Thomson, Mr. Carmichael, and the President took part. Capt. R. F. Burton read a paper on some Neolithic Stone Implements and other objects brought by himself and Capt. Cameron from Wásá, on the Gold Coast. A large number of objects were exhibited by the authors and Mr. Ross. General Pitt-Rivers read a paper on the Egyptian Boomerang, and exhibited several specimens. A large collection of Bushman drawings was exhibited by Mr. M. Hutchinson.

A NEW volume of the Classified Catalogue of the Library of the Royal Institution of Great Britain, by Mr. Vincent, the Librarian, is now ready; it includes the most important works published during the last twenty-five years, placed under their respective heads, accompanied by a Synopsis and Indexes of Authors and Subjects.

THE half-yearly general meeting of the Scottish Meteorological Society will be held to-day. The business consists of (1) Report from the Council of the Society; (2) Address by D. Milne Home, of Milne Graden, Chairman; (3) The Rainfall of the British Islands, by Alexander Buchan, Secretary; (4) The Climate of Jerusalem, by Alexander Buchan, Secretary.

IN a paper recently read before the Asiatic Society of Japan, entitled "Religious and political ideas of the early Japanese; beginnings of the Japanese nation, and credibility of the national records," Mr. B. H. Chamberlaln (according to the *Japan Mail*), after mentioning the difficulties which beset investigation, and giving an analysis of the religious and so-called historical traditions of early Japan, proceeded to draw, both from the matter itself and from the manner in which it was put together in the histories as we now have them, several conclusions as to the condition of the early Japanese, and the influences which moulded them into the united nation which meets us at the dawn of authentic history. The most important of these conclusions were:—1. That there were three centres of legendary cycles in ancient Japanese, Idzumo, Yamato, and Kinshsiu, and that the country was probably divided into three or even a greater number of states. 2. That instead of having only begun to communicate with the mainland of Asia at about the year 200 A.D., as was commonly supposed, there had never been, so far as we can judge, a time when communication did not exist, and that much of the so-called autochtonous civilisation was really imported, as was proved by a sifting of myths, and even by the test of language, the most archaic form of Japanese, containing a number of Chinese words for implements or ideas that had themselves been borrowed. 3. That authentic history did not in Japan go back farther than A.D. 400, *i.e.* more than a thousand years later than the date commonly accepted for its commencement. Mr. Chamberlain noticed in detail the items scattered through *Kozhiki*, or oldest monument of Japanese literature, relative to the governmental arrangements and religious belief of ancient times, and showed that Shinto was not a religious system properly so-called, but rather a bundle of miscellaneous and often inconsistent superstitions.

DURING a heavy thunderstorm in the Shetland Islands on Tuesday, which lasted several hours, a hill, three miles from Lerwick, was struck by lightning, and huge masses of rock and *débris* were thrown down on the public road which the hill overhangs, filling up the road and the valley at the other side, and suspending traffic. The total weight of the fallen rock is estimated at 400 tons.

LAST week the statue of Mariette Bey, the great French Egyptologist, was unveiled at Boulogne, in presence of a large assembly, including several high officials of the French Republic.

THE report on the proposed grant to the French Minister of Posts and Telegraphs of a sum of 3600*l*., in view of the meeting of Electricians, has been sent to the French Senate, after having been adopted by the Chamber of Deputies. This meeting will take place only in October. One of the reasons alleged for the delay is the necessity of installing the magnetic instruments now in course of construction for the Observatory of Paris. The assent of the French Senate is stated to be beyond a doubt.

FROM the "Mineral Statistics of Victoria" for 1881 we see that the quantity of gold raised last year was 858,850 oz., being 29,729 oz. more than the quantity obtained in 1880. The deepest shaft in the Colony is the Magdala at Stawell, which is 2409 feet deep.

SOME instructive results have been recently obtained by M. Spring, in studying the dilatation of isomorphous substances (*Bull. Belg. Acad.*, No. 4). He experimented with five alums. These, he shows, expand very regularly, and very little with rise of temperature from zero till a critical temperature is reached (different for each), at which there is rapid expansion, indicating decomposition. Up to 60°, the mean critical temperature, these alums may be said to expand equally, and M. Spring is led to affirm that *isomorphous substances have the same coefficient of expansion*, or at least coefficients very little different. A probable inference is that they have the same coefficient of compressibility; this he has yet to test. Thus, a similarity in

physical properties, between isomorphous substances and gases, is suggested; and a law similar to Avogadro's may be applicable, viz., equal volumes of those (isomorphous) substances must contain the same number of molecules. In verification of this is the fact shown by M. Spring, that the quotients of the specific weights of the alums by the respective molecular weights are equal. Thus the law of Avogadro, verified hitherto in its consequences only for gases, may be found to strike its roots even into solid bodies, and the problem of determining the molecular magnitudes of the latter may one day receive a solution conformably to modern theories of chemistry. M. Spring is extending his examination to other isomorphous substances, and will also study the ratio of expansion and contraction in heteromorphous bodies.

THE third instalment of Dr. Hermann Müller's "Further Observations on the Fertilisation of Flowers by Insects" is occupied by observations, supplementary to those recorded in his "Befruchtung der Blumen durch Insekten," on the insects which visit particular species and assist in their pollination, with some notes on corresponding peculiarities of structure in the flowers themselves. It is illustrated by a very beautifully executed plate.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Lady Parkyns; an Egyptian Fox (*Canis niloticus*) from Egypt, presented by Mr. Horace Kemp; two Coypu Rats (*Myopotamus coypus*) from South America, two Common Night Herons (*Nycticorax griseus*), European, presented by Mr. A. A. van Bemmelen; two Californian Quails (*Callipepla californica*) from California, presented by Mr. J. Biehl; a Crocodile (*Crocodilus*, sp. inc.) from Black River, presented by Mrs. A. H. Jamrach; an Æsculapian Snake (*Coluber æsculapii*) from Central Europe, presented by Lord Arthur Russell, M.P.; two Australian Fruit Bats (*Pteropus poliocephalus*), a Black-breasted Peewit (*Sarciophorus pectoralis*), an Australian Monitor (*Monitor gouldi*) from Australia, two Porto Rico Pigeons (*Columba corensis*) from the West Indies, a South American Jabiru (*Mycteria americana*), two Brown Thrushes (*Turdus leucomelas*) from South America, two Demoiselle Cranes (*Anthropoides virgo*) from North Africa, three Blue-shouldered Tanagers (*Tanagra cyanoptera*), a Striated Tanager (*Tanagra striata*), a Tanager (*Saltator*, sp. inc.) from Brazil, two Scops Owls (*Scops asio*) from North America, two Yellow Sparrows (*Passer luteus*) from East Africa, two Beautiful Waxbills (*Estrelda formosa*) from India, purchased; a Two-spotted Paradoxure (*Nandinia binotata*), a Hybrid Sclater's Muntjac (between *Cervulus muntjac* ♀ and *Cervulus lacrymans* ♂), born in the Gardens. The following insects have emerged in the Insect House during the past two weeks:—Silk Moths: *Actias selene, Telea polyphemus, Telea promethea*; Moths: *Ceratocampa imperialis, Bombyx castrensis, Zygæna filipendulæ, Liparis monacha, Deilephila vespertilio, Deilephila euphorbiæ, Bembecia hylæiformis, Plusia concha*; Butterflies: *Parnassius apollo, Melanagria galathea, Gonopteryx rhamni, Vanessa io, Vanessa polychlorus, Araschnia levana* var. *prorsa, Theela betulæ, Theela spina, Epinephele janira, Erebia blandina*.

OUR ASTRONOMICAL COLUMN

THE WEDGE PHOTOMETER.—In a communication to the American Academy of Arts and Sciences in May last (NATURE, vol. xxvi. p. 259), Prof. Pickering has some remarks upon the use of a wedge of shaded glass as a means of measuring the light of the stars. He considers that, while it has been maintained by some writers that it is not a new device, "the credit for its introduction as a practical method of stellar photometry seems clearly to belong to Prof. Pritchard, director of the University Observatory, Oxford." Various theoretical objections to this photometer have been advanced, and many sources of error suggested, but Prof. Pritchard has made the best possible reply to them by measuring a number of stars, and showing that his results are in very close agreement with others obtained elsewhere by wholly different methods. His photometer "consists of a wedge of shade glass of a neutral tint inserted in the field of the telescope, and movable, so that a star may be viewed through the thicker or thinner portions at will. The exact position is indicated by means of scale." The measure of the brightness of the star is made by bringing it to the centre of the field and moving the wedge from the thin towards the thick end until the star disappears. Stars must always be kept in the centre of field to insure the readings being comparable. But Prof. Pickering makes the ingenious suggestion that this photometer may be further simplified by substituting the earth's diurnal motion as a measure of the position of the star in the wedge at disappearance. "It is only necessary to insert in the field a bar parallel to the edge of the wedge, and place it at right angles to the diurnal motion, so that a star in its transit across the field will pass behind the bar and undergo a continually increasing absorption as it passes towards the thicker portion of the wedge. It will thus grow fainter and fainter, until it finally disappears." Then the interval of time from the passage behind the bar until the star ceases to be visible becomes a measure of its light, and the time will vary with the magnitude. As in Prof. Pritchard's form of the instrument, it is only necessary to determine the value of a single constant. Prof. Pickering adds some suggestions with regard to observations with this photometer, and recommends them to the attention of amateurs.

THE OBSERVATORY IN YALE COLLEGE, U.S.—Prof. H. A. Newton, who was appointed Director of the Winchester Observatory in Yale College, New Haven, U.S., in May last, has drawn up a report on the present state of this establishment, and of the preparations in progress for placing the instruments in new buildings specially erected to receive them. The heliometer ordered from Repsold, of Hamburg, two years since, was received last spring; the cost, including freight, and other expenses to New Haven, being close upon 7460 dollars. To supplement the heliometer, and also for independent work, an equatorial telescope of 8 inches diameter was ordered from Mr. Howard Grubb of Dublin, and is expected in August. (No mention is made by Prof. Newton of the 9-inch Alvan Clark refractor, which Yale College was stated to possess in the Smithsonian report on astronomical observations in 1880). About nine acres from the southern extremity of the observatory lands have been set apart as a site for the observatory, and the erection of two towers for the heliometer and equatorial respectively, has been commenced. The heliometer tower was expected to be ready for the instrument early in July, the dome constructed by Mr. Grubb having been already put in place. It is intended by Prof. Newton to undertake such work with it, immediately it is available, as shall prepare for the most advantageous use of the instrument during the approaching transit of Venus. In the Smithsonian report referred to, the diameter of the object-glass is stated to be 6 inches.

The income derived from the fund set apart by the late Hon. O. F. Winchester, is to be applied for the maintenance of the observatory. The 8-inch equatorial has been purchased from funds generously provided by a private individual, who for the present does not desire his name to be mentioned. Under the direction of Prof. H. A. Newton, supported by such liberality, astronomers will look forward to a bright future for the "Observatory in Yale College"—as, with the assent of Mr. Winchester's family, the institution is to be called.

THE TRANSIT OF VENUS.—In consequence of the sudden death of Mr. Burton, who, as we mentioned last week, had been appointed observer at Aberdeen Road, Cape Colony, we understand Mr. A. Marth will have charge of that station.

It is not improbable that some readers may contemplate proceeding for the purpose of observing this phenomenon (which will not recur till the year 2004), where it is visible from ingress to egress, and perhaps with a view at the same time of escaping a winter in this climate. If such there be, they might not readily fix upon a more advantageous station than the Blue Mountain range in the island of Jamaica or its vicinity. Calculating for a point in longitude 77° 30′ W., latitude 18° 5′ N., the times of contacts and sun's altitudes are as follows:—

		Local mean time. h. m. s.		Sun's altitude. ° ′
First external contact,	Dec. 6	8 52 37 a.m.	...	30 15
,, internal ,,	,,	9 13 23 a.m.	...	33 54
Last internal ,,	,,	2 39 5 p.m.	...	32 17
,, external ,,	,,	3 0 22 p.m.	...	28 29

WELLS' COMET.—The following places of this comet are for Greenwich midnight :—

	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth.	Sun.
July 27	11 39 1	+5 58·7	0·2614	0·1380
29	11 44 41	5 38·3	·2732	·1506
31	11 50 5	5 18·5	·2867	·1626
August 2	11 55 14	4 59·3	·3004	·1742
4	12 0 9	4 40·6	·3126	·1853
6	12 4 51	4 22·7	·3244	·1960
8	12 9 22	4 5·2	·3358	·2064
10	12 13 43	3 48·2	·3469	·2164
12	12 17 54	3 31·7	·3576	·2260
14	12 21 56	+3 15·7	0·3680	0·2354

The calculated intensity of light on August 9 is equivalent to that at the first Harvard College observation on March 19.

COMET-SEEKING IN THE SOUTHERN HEMISPHERE.—From a communication to the *Sydney Morning Herald*, we learn that Mr. Tebbutt, of Windsor, N.S.W., the discoverer of the great comet of 1861, has, at the instance of the Boston (U.S.) Scientific Society, undertaken the organisation of a corps of amateur comet-seekers in Australia, and with this object has addressed a circular to several persons in the colonies, who have manifested an interest in the science. We wish Mr. Tebbutt every success: the matter could not be in better hands. It would be easy to adduce numerous cases where the theories of these bodies have suffered from the want of southern observations, and it may be hoped, that in conjunction with the systematic search undertaken by a number of observers in America, and, we are glad to add, in this country also, it will be quite an exceptional case for a comet within range of ordinary telescopes to escape detection, as we know many have done in past years. The additions to the number of comets of short period during the last fifteen years, are alone a sufficient inducement to institute more systematic examination of the heavens in future.

PHYSICAL NOTES

AN organ-pipe sonometer is described in the *American Journal of Science*, by Mr. Le Conte Stevens. The ordinary resonance box of the sonometer is in this instance replaced by a double organ-pipe of spruce fir-wood, tuned to give the note C = 132 vibrations. Three steel wires are stretched above, two being tuned to the fundamental, the other strained to various degrees of tension by a lever and a sliding weight. There are also arrangements for sharpening or flattening the note of one of the pipes at will, so as to produce beats. By varying the wind-pressure, the natural harmonics of the pipes can be produced. The object of the instrument is to afford a convenient means of producing the notes of the natural scale and those of the tempered scale, by way of contrasting them with one another. The apparatus has several other uses as a lecture instrument in acoustics.

M. CAILLETET has invented a new pump for compressing gases to a high degree of compression. The main point in its construction is the method by which he obviates the existence of useless space between the end of the piston-plunger and the valve, which closes the end of the cylinder. This he accomplishes by inverting the cylinder and covering the end of the plunger with a considerable quantity of mercury. This liquid piston can of course adapt itself to all the inequalities of form of the interior space, and sweeps up every portion of the gas, and presses it up a conical passage into the valve. The valve by which the air enters the body of the pump is opened by a cam-gearing after the descent of the piston below point where the air rushes in.

ANOTHER suggestion due to M. Cailletet is worthy of notice, and is applicable to many pieces of laboratory apparatus beside air-pumps. It is the employment of *vaseline* as a lubricant wherever there is a liability of the presence of mercury; for, as is known, most oils and fatty matters clog with finely-divided mercury, and are objectionable on this account.

NEW forms of secondary battery continue to make their appearance, most of them based upon the accumulator of Planté. Mr. R. E. Crompton has lately patented a process for giving a large effective surface to the leaden electrodes by making it porous, by adding to the lead some other substance capable of being extracted by the action of acid, or by heat, or by other reagents. Another modification due to Messrs. Biggs and Beaumont, consists in collecting in a separate vessel the hydrogen or other products of decomposition, in the accumulator, the collected products being afterwards recombined as fast as required. The electrodes in this case are composed of finely divided lead.

WE have also received a report of a lecture delivered by M. Maurice Lévy before the Societé d'Encouragement on the same subject of electrical units. It speaks volumes for the mathematical education given in the public schools of Paris, if an audience of a society comparable to that of our Society of Arts could follow the lecturer through a mathematical discussion like that before us, which includes a discussion of the doctrine of dimensional equations, and of the elimination of arbitrary coefficients. M. Lévy applauds the decisions of the Congress, which he expounds logically and elegantly.

THE following experiment of Messrs. Jamin and Maneuvrier illustrates the presence of an inverse electromotive force in the voltaic arc, dependent on the actions therein excited by the current. A continuous current was passed first from coke to mercury, producing a reddish coloured arc. The current was then reversed, when the arc appeared green, and the metal volatilised rapidly. Then the current of an alternating Gramme machine was passed through the same arrangement. The arc now appeared green, showing a predominance of the current from mercury to coke, although in ordinary circumstances the two alternately directed currents are absolutely equal in strength.

THE decisions of the Electrical Congress have aroused the electricians of several Continental nations to realise the advance in exact science which the adoption of a uniform system of electrical units implies; and not to be behindhand, they are striving to spread a knowledge of what has been done. The new determination which is to be made of the value of the ohm has furnished material for several discussions, in which it is curious to observe the suggestions that were brought forward as new. Others content themselves with expounding that which has been already done. We have before us, from the pen of Dr. Guglielmo Mengarini, assistant in the Physical Institute of the University of Rome, a "History of the Electromagnetic Unit of Resistance," reprinted from the official bulletin of the Minister of Public Instruction. Beginning with the work of Davy, Becquerel, Ohm, and Wheatstone, the author describes how gradually the rheostat brought forth the resistance-coil, and the units of Siemens and of the British Association. He then gives a theoretical discussion of the absolute electromagnetic unit of resistance, and an account of the methods of Weber and of the British Association for determining it. The main points in the propositions submitted to the International Congress at Paris in 1881 are then given, together with the formal decisions of the Congress thereupon.

A VALUABLE contribution to the subject of the electricity of flame has been lately made by Herren Elster and Geitel (*Wied. Ann.* No. 6). The discrepancies in previous results are attributed largely to the behaviour of the air layer immediately outside of the flame having been left out of account. The authors used a Thomson quadrant electrometer for measurement. They find the supposed longitudinal polarisation of flame merely apparent, and due to unequal insertion of the wires used as electrodes. On the other hand, flame is strongly polarised in cross section; an electrode in the air about the flame is always positive to one in the flame. The theory the authors adopt is this:—By the process of combustion *per se* free electricity is not produced in the flame; but the flame-gases and the air-envelope have the property of exciting, like an electrolyte, metals or liquids in contact with them. To this electrolytic excitation is added a thermo-electric, due to the incandescent state of the electrodes. The amount and nature of the electric excitation is independent of the size of the flame, and dependent on the nature, surface-condition, and glow of the electrodes, and on the nature of the burning gases. *Inter alia*, it is remarked that flames may be combined in series like galvanic elements, and so as to form a "flame-battery."

IN a recent dissertation (*Wied. Ann.* No. 7), Herr Heine describes experiments on the absorption of heat by gas-mixtures with varying percentage of constituents, and he thence deduces a method of ascertaining the amount of carbonic acid in the air. Varied mixtures of CO_2 and air, in known proportions, were

formed in a tube to which the heat of a Bunsen burner was admitted (through a rock-salt plate); and the resultant variations of pressure were recorded by means of a Knoll pantograph. The curve obtained (with percentages as abscissæ and indicated pressures recorded as ordinates) shows, as one might expect, a decrease of rise of pressure through absorption of heat, with decrease of CO_2, but the two are not proportional. With regular decrease of CO_2 from 100 per cent., the fall is slight, in the curve, to about 5 per cent., and thereafter rapid to zero with pure air. (Mixtures of CO_2 and H gave a different curve, with a much lower position throughout.) By chemical methods the CO_2 has been shown to vary between 0·02 and 0·05 per cent. Hence it was desirable to develop the corresponding part of the curve just described with special care. This was done, and atmospheric air, freed from moisture, but not from CO_2, was admitted to the apparatus. The tabulated results of fifty analyses made thus, in four days, at Giessen, appear to prove the applicability of the method. (The proportion of CO_2 varied between 0·020 and 0·034.) Its advantages are: only small quantities of air (one or two litres) being required, and the operations being quite simple, and taking little time (say half an hour). It is suggested that the aqueous vapour in air may be similarly measured.

A THIRD instalment of researches on transpiration of vapours, by Herr Steudel, at the instance of Prof. Lothar Meyer, is described in *Wied. Ann.* No. 7; it relates to alcohols and their halogen derivatives, and to some substitution-products of ethane and methane. In a concluding paper Prof. Meyer reviews the inquiry. The supposition is confirmed, that homologous series, even with very different molecular weight, have for the most part nearly the same constants of friction. (All compounds containing one carbon atom show strong divergence.) The influence of the nature of the contained atoms, on friction, is remarkable. Thus, with about equal molecular weight, iodine produces a much greater friction than bromine, and the latter a greater than chlorine. Far-reaching conclusions as to the form of molecules, Prof. Meyer is not prepared to draw, but the cross section of the molecule of a tertiary butylic compound is inferred to be less than that of the corresponding secondary, and the latter less than that of the primary. This agrees with received views as to the linking of these compounds. The molecular volumes reckoned from the friction of vapours, stand to each other in nearly the same ratios as the molecular volumes in the liquid state at boiling point.

FROM observations made several years ago, Prof. von Reusch of Tübingen was led to think the hydrophane of Czernowitza a substance peculiarly well fitted for diffusion experiments with gases. Its properties in this relation have now been carefully studied by Herr Hufner (*Wied. Ann.* No. 6); and *inter alia*, it is shown that the resistance to passage of a number of gases is related both to the coefficients of absorption and the specific gravities; all three increasing in the same sense (but not in simple proportion).

AN interesting analogy to thermoelectric phenomena, &c., is given by M. Bouty in the *Journal de Physique* (June). Suppose a tubular ring, impermeable to heat, containing in its lower half sand saturated with water, and in its upper air saturated with water-vapour. If heat be applied at one end (A) of the sand, a circulation is set up, the water being vaporised at A, condensed at the opposite end B, and filtering through the sand to replace the water evaporated at A. Again, suppose (instead of heat) a rotary pump acting about the middle of the air space; a circulation is produced, and the water evaporating at A causes a fall of temperature, while the condensation at B causes a rise; an image is thus presented of Peltier's phenomenon. The junction A, which is cooled, is precisely the one which must be heated to produce the existing circulation, and the quantity of heat absorbed at A is proportional to the weight of water evaporated per second, that is, to the intensity of the current.

SIGNOR MARTINI (*N. Cim.* [3] 9, 1881) obtains diffusion figures thus: A glass vessel is filled with two liquids little differing in density, *e.g.* water and an aqueous solution of salt or sugar. They are left at rest for an hour. A capillary tube entering the bottom of the vessel is connected by caoutchouc tubing with a movable vessel of coloured alcohol. When the latter enters by the capillary, it rises as a thin spiral thread, but on reaching the lighter liquid it spreads into fine tree-shaped figures. Figures of umbrella shape are produced, if the heavier liquid be used in place of the alcohol.

PROF. T. C. MENDENHALL, of Columbus, Ohio, communicates to the *American Journal of Science* a paper on the Influence of Time on the Change of Resistance of the Carbon Disk of Edison's Tasimeter. This resistance was found, when pressure was removed suddenly, to return to its maximum value; but when pressure was applied, time was necessary to enable the resistance to reach its minimum. On applying pressure, the resistance fell a little more than 3 per cent. in one minute, about 5 per cent. in three minutes, and about 10 per cent. in one and a half hours.

CONTRARY to the opinion now generally received concerning the alleged change of resistance of carbon under pressure, Mr. Mendenhall, in the communication alluded to in the preceding note, asserts that the effect is not due to better surface contact. His own experiments were made with one of Edison's compressed lampblack buttons resting in its place in the tasimeter, and covered by an "upper contact piece." This is all the information given upon this vital point of how the contacts were made, and in the absence of any evidence of care or precautions to ascertain whether the contact was perfect or not, the opinion pronounced must be regarded as worth very little.

GEOGRAPHICAL NOTES

THE *Journal* of the Straits Branch of the Bengal Asiatic Society for December, 1881, contains a short comparative vocabulary of the Fijian and Maori (New Zealand) languages, with notes by Mr. Thurston and Sir F. A. Wild. The Maori is a recognised member of the Eastern Polynesian linguistic family, and from these specimens the Fijian might be supposed to belong to the same connection. But the natives, especially of the eastern islands of the Fiji Archipelago, have long been exposed to Polynesian influences, through their relations with the Tonga islanders. These influences are apparent both in their physical type and in the numerous dialects current on the coast. But the skulls of the Kai Colos occupying the interior of Viti Levu have been shown by Prof. Flower to be of a distinctly Papuan character. In fact, they are the most dolichocephalic on the globe. The outward appearance of the Kai Colos and other tribes removed from contact with the Tonga people also closely resembles that of the pure Melanesians of the New Hebrides and Solomon groups. Specimens of their speech have not yet been collected; but it may be taken for granted that it will be found to be of a distinctly Melanesian type, betraying little or no affinity to the Polynesian. Such vocabularies as these, while possessing a certain value, are apt to be very misleading, and have in fact contributed to the current belief that the Polynesian and Melanesian tongues are fundamentally one. In reality they possess nothing in common beyond the verbal resemblances due to the wide-spread Polynesian influences in the Melanesian domain. In their morphology and inner structure, the two systems are radically distinct.

HIRT, of Breslau, has published a second part of the "Geographische Bildertafeln," by Dr. Oppel and Herr Arnold Ludwig, the first part of which we noticed recently. This part is devoted to typical landscapes, and the selection seems to us to have been made with great discrimination. For Great Britain, for example, we have Loch Ness in Scotland, a Scotch Moor, the Giants' Causeway, the Dover Coast, a Welsh Valley, and an extensive landscape on the Upper Thames. All the other leading countries of Europe are treated after a similar fashion, while representative scenes are given from the great divisions of the other continents. The interest and utility of such a collection are obvious. The same publisher issues also a coloured panorama, showing the chief forms of the land and water on the surface of the globe, much superior to the publications of the same class with which we are familiar in this country.

LIEUT. GIRAUD has sailed from Marseilles for Zanzibar, as leader of a French expedition which proposes to take up African exploration where Livingstone laid it down with his life on the south shore of Lake Bangweolo. Lieut. Giraud proposes to go either direct west to Lake Tanganyika, or, more probably, by the north shore of Lake Nyassa, to the Chambeze River. This he will follow to its outlet in Lake Bangweolo, which he proposes to circumnavigate. He will then attempt, in canoes, to sail down the Luababa-Congo, to its mouth in the Atlantic Ocean. This is an ambitious programme; and every one interested in African exploration will wish the expedition complete success.

THE current number of the *British Quarterly Review* contains an article on recent Japanese progress, which is by far the most valuable that has been published on this subject for many years past. The author, Col. H. S. Palmer, R.E., describes fully the causes and course of the changes which have passed over the "Land of the Rising Sun" in the past fourteen years; the various and complicated changes in the constitution and administration—from the pure oligarchy which succeeded the revolution of 1868, to the system of tolerably free local government of the present day—are clearly explained, and the effect of the various steps in these changes made comprehensible to the general reader. The writer then takes the recent reforms under various heads—the army, navy, education, public works, prisons, &c.—and shows, by statistics, what advance has really been made. The last half of the paper is, in fact, a comprehensive summary, with running commentary, of the Japanese government statistics in every department. The knotty subject of finance is treated with as much clearness as the subject admits of. Under this head the almost inevitable character of the present financial depression is explained; but it is gratifying to notice that a careful and impartial observer like Col. Palmer is able to conclude his article with confidence in the future of the country to which he has devoted so much study. Many of the interesting statistics in the paper have already appeared in the columns of NATURE.

DR. HOLUB has sent us several papers connected with his South African explorations. There are two on the English in South Africa, from the standpoint of exploration and civilisation, and a similar paper on the French in Tunis; and an interesting Catalogue, with notes, of Dr. Holub's ethnographical collections.

IN connection with Egyptian troubles, Mr. Wyld has published two maps, which may be useful to those who are watching operations. One is a plan of Alexandria and the harbour, with an inset map showing the British possessions in the Old World; the other is a small map of the Isthmus of Suez and Lower Egypt, on the scale of twelve miles to an inch, with a similar inset map.

CONTRIBUTION OF ASTRONOMY TO THE PROBLEM OF MOLECULAR PHYSICS[1]

THE kind way in which you have received me, leads me to fix, by writing, the principal points of our conversation on Sunday last. I thank you heartily for offered help to realise the scientific aim I have in view, and which I will now explain.

The synthetic study of thermo-chemical phenomena, of the laws of thermo-dynamics and of experiments relating to these subjects of the physical sciences, has brought us to consider the *temperature* of a body as being the *mean amplitude* of the vibratory oscillation of molecules constituting that body.

This definition, taken as a starting point, enables us to explain and deduce all the essential laws of the mechanical theory of heat. We obtain from it easily the law of Dulong and Petit, that of isomorphism in systems of crystallisation, the relations connecting the coefficients of expansion of all substances with their atomic weight, their temperature of fusion and their density, &c.

The maximum tensions are calculated in advance with all exactness, and lastly, the two great mechanical principles of heat are an immediate and necessary consequence of it.

I have, then, every reason to believe that this definition will be adopted, since it satisfies as well the condition of integrability of the differential equation of motion (function S of Zeuner) as the definition drawn from the air or mercury thermometer (definition of Regnault).

In that case, what is the *specific heat* of a body?

The specific heat becomes the sole manifestation of the *attraction* of molecules for one another.

Indeed, if we multiply the *space traversed* (temperature) by the *molecular force* (specific heat), we obtain the total heat or quantity of absolute work which the substance contains.

Here, consequently, comes in an important question, which is by no means secondary, as has often been said—

Is the attraction of matter for matter a fundamental essential property of matter, or is it merely the result of the dynamical action of the medium in which the matter exists?

In other terms, may one say, without its being possible to explain it, Matter attracts matter without the active intermediary of the medium; or, Attraction as a *force* does not exist; it is merely the manifestation of shocks of the ether which tend to approximate bodies according to the Newtonian law?

In the former case, one regards the *attractive potential* of matter as an original capital placed in each material element, a capital which is only exhausted by the absolute approximation of all matter existing in the universe. In the latter case this potential is *nil*, and one supposes that a certain quantity of kinetic energy has been communicated in the beginning of time to the mass of the universe, a quantity of energy which is inevitably transformed under a thousand different combinations into all the physico-chemical and astronomical phenomena of nature.

In the former case $\frac{1}{2}mv^2$ + *the potential is constant.*

In the latter, $\frac{1}{2}mv^2$ *alone is constant.* The solution of this important question is necessary to establish physical theories in a somewhat distinct manner, and to prove the intimate relation existing between the various elements of bodies.

On the hypothesis that *attraction* is an essential property of matter, we shall liken it to *inertia;* thus any body will possess as primordial characters, a certain quantity of inertia, without which we should never come to be put in contact with it nor to know it, and a certain quantity of *attraction*, which will be the manifestation of its proper influence on the rest of the universe. Such will be the conditions of existence of matter.

On the hypotheses that $\frac{1}{2}mv^2$ alone is constant, *inertia* and *motion* are the fundamental properties of matter; *shocks* are the means of transformation of different modes of motion.

Let us take, then, any body and heat it.

If we are partisans of the first hypothesis, that of *potential*, we must expect to find simple relations between the *inertia of the body considered, the attraction of the molecule for one another, and increase of volume of the body*, the whole associated with the quantity of mechanical work furnished to the body in the form of heat.

The *specific heats* and *latent heats* will then be functions of the *atomic weight* or *inertia* of the body, and the dissociation which is manifested by *fusion* and *volatilisation*, will be deduced from the study of the body under these two aspects, masses set in motion, and *potential* of those masses.

If we are partisans of the second hypothesis, supposing that $\frac{1}{2}mv^2$ is constant, we are obliged simply to consider the volume of the body; that is to say, the exterior surface of the smallest quantity of matter.

Indeed, shocks alone explain the phenomena. But when one says *shock*, he says *surface* where the shock occurs. The greater the surface the larger the number of shocks of the ether, the stronger the reaction of the matter.

We must expect them, in this second hypothesis, to find simple relations between the volumes of atoms and of molecules, that is, between the co-efficients which represent the density of the bodies, the number of atoms and the atomic weight, and the specific heats, latent heats, and maximum tensions.

In other terms, in the first hypothesis, molecular physics will rest essentially on the *atomic weight*, which, by virtue of the fall of bodies, represents simultaneously the idea of *inertia* and that of *attraction*, essential properties; in the second hypothesis the physico-chemical phenomena are deduced mainly from the *volume* of atoms and the *medium* in which the phenomena occur.

The *medium* becoming *active*, a variation of medium will induce in phenomena of attraction concomitant variations quite independent of matter itself.

The *specific heats* and the *latent heats* may then be variable elements in the same substance and *at the same temperature* under the same pressure, according to the *mechanical energy of the medium* in which the phenomena occur.

Thus the whole of molecular physics is closely connected with the solution of this theoretical question.

We have sought an experimental method capable of throwing some light on this problem. Without entering into too minute details, we will explain the plan of this work.

It may be accepted, I believe, that the solar system is nearly independent, mechanically speaking, of the rest of the universe; that is to say that no motion, relatively to the centre of gravity of this system, is produced in our planets by the perturbation of other systems surrounding us.

We may then call M the total mass of the solar system. This mass is decomposed into m, m^1, m^2 . . . the respective masses of the Sun, Venus, the Earth, Jupiter, &c., and μ the mass of

[1] A letter from M. Raoul Pictet to M. Dumas, dated Paris, December 16, 1881, and published in *Archives des Sciences*, June 15.

the ether, whose density is function of the velocity of propagation of light and heat, as also of the wave-lengths.

Multiplying all these masses by the square of the velocity of each particle relatively to the centre of gravity of the solar system, we obtain the factor $\frac{1}{2} Mv^2$ = the total kinetic energy of the solar system.

This constant kinetic energy (if the second hypothesis be admitted, in which $\frac{1}{2} m v^2$ is constant) is not distributed throughout the solar system in a regular and fixed manner. Sometimes a planet, as Jupiter, is at the extremity of the larger axis of his ellipse, and advances more slowly; sometimes, on the contrary, his velocity is accelerated and passes through a maximum to another position of his orbit.

At the same minute all the planets are revolving round the sun, some with their maximum velocity, others with their minimum velocity, others, again, with intermediate velocities. We may make addition of all these kinetic energies of the whole solar system, and differentiate the total equation with reference to time. The *variations* thus obtained *for each hour* will naturally eliminate all the *quantities of constant kinetic energy* represented by the rotation of the stars on their own axes; they will merely show the increase or the diminution of the whole of the variable kinetic energies of the system.

One may easily draw a curve of these variations calculated by the ephemerides of the principal planets. Jupiter will play a preponderating *rôle* in this calculation.

Considering still the second hypothesis, in which the attraction is merely the result of shocks, it is evident that the attraction manifested by each planet for the bodies which are on its surface will be the echo of the kinetic energy disposable on this planet. *This kinetic energy will be variable according to the day and hour of observation.*

In fact, the kinetic energy of the solar system *being fixed and constant*, if the planets, on a certain day, absorb into their own mass a maximum quantity of kinetic energy, the *cause of gravity on the earth* will be diminished by the whole of the excess which is accumulated in these bodies in motion, and the *acceleration* g will pass through a *minimum*. On the other hand, when, a few years later, the whole of the planets give a minimum total of kinetic energy for their masses in motion, the value of g, for the same reasons, must pass through a maximum.

It is easily understood that the value of the terrestrial attraction cannot remain constant if the disposable kinetic energy varies in function of the time and of the respective position of the other planets.

Now, we may calculate the total mass M of the system, the partial masses and their variable velocities; we obtain for these variations *considerable values*; then if we register carefully the values of g obtained directly during observations which must continue at the least several years, and if we trace a curve of the values of g so obtained, we should find the following coincidence:—

The curve of variations of the total kinetic energy of the planets must be inverse to the curve of values of g referred to the same time.

The differences between the maxima and the minima of the two curves, taken on the same ordinate, will give the measure of the velocity of propagation of the kinetic energy in the ether of the solar system.

These conclusions are rigorous in the case of the hypothesis,

$$\frac{1}{2} mv^2 = \text{constant},$$

being in accordance with nature.

In the case, on the other hand, of attraction being an essential property of matter, and of our having—

$$\frac{1}{2} mv^2 + \text{the potential} = \text{constant},$$

we should find for g a *constant*, since g is the sole manifestation of a constant potential, supposing the mass of the earth is constant during the course of the observations of g.

It will be necessary, then, to take account of perturbations of the moon for the measurements of g, as also of those of the sun, then to verify whether, these corrections having been made, g is constant.

I believe that this experimental method is the only means we possess of diagnosticating with certainty on the essential properties of matter, and of deciding between those two great theories which are both maintained by men of incontestable merit.

As to the measurement of g, there are several operative processes, and it will be indispensable, before commencing observations, to discuss analytically the advantages of each of them, and the modes of inscription of the values obtained.

The optical means of registration, the mechanical actions connected with the motion of pendulums, and the kind of pendulums, will be so many important subjects of discussion, in the case of taking these researches in hand, which I consider as very useful for the definitive settlement of physical theories.

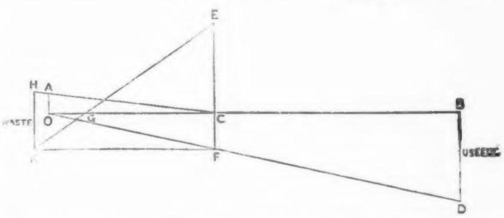
This is a rather long letter, you see, dear Teacher; but I thought to explain to you the object which I pursue, in its general traits, happy indeed if the experiments may be undertaken under your benevolent auspices.

Accept, dear Teacher, I pray you, the expression of my gratitude and entire devotion. RAOUL PICTET

A GEOMETRICAL CONSTRUCTION GIVING THE RELATION BETWEEN THE WASTE AND USEFUL WORK IN A SHUNT DYNAMO

THE ratio between the portion of electrical energy utilisable in the external circuit of a shunt dynamo and the portion wasted in heating the wire of the armature and field magnet is easily calculated as soon as one knows the resistances of the armature and magnet wires, and the resistance equivalent to the external circuit; and I do not know that there is any great advantage in putting it into a geometrical form. Still there are people who prefer a construction to a formula, and the following construction is easily made, especially with the use of squared paper.

In the figure annexed, let O A represent the resistance of the armature between the points where the branching occurs; O B



the resistance of the field magnet wire; and O C the resistance of the external circuit, or its equivalent.

Erect lines to represent the useful work (E.M.F. × current), on any convenient scale, at C and at B; viz. C E and B D.

Join O D, producing E C to meet it at F.

Lay off C G equal to E F; draw E G and a horizontal through F.

Then from their meeting point K draw a vertical, meeting C A in H.

The length H K so determined represents the waste portion of the total electrical energy, on the same scale as B D or E C represents the useful.

In this figure the effect of the armature resistance in tilting up the line C A and so increasing the waste is very manifest; the increase of waste by decreasing the resistance O B is somewhat less striking, but quite distinct; the effect of a change in O C is, as it should be, not so obvious. It may be noted that the most economical value for O C is very nearly indeed a geometric mean between O A and O B–O A; which is an easy rule to apply in practice.

Liverpool, July 19 OLIVER J. LODGE

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE following is the list of candidates successful in the competition for the Whitworth scholarships, 1882, in connection with the Science and Art Department:—Charles Webster, apprentice; John H. Tomlinson, apprentice; James M. Beaman, fitter; Thomas Turner, engineer; D. Codrington Selman, engineer; Charles B. Outon, draughtsman; George H. Banister, draughtsman; Frederick Lane, fitter; William D. Laird, engine fitter; Joseph Parry, engine fitter; Albert F. Ravenshear, apprentice; Charles W. Carter, brass-finisher; Alfred Barrow, fitter; Henry C. King, fitter; Malcolm Douglas, apprentice; Thomas H. Gardner, engineer; Ernest E. Haine, engineer; George Halliday, engineer; George W. Buckwell, draughtsman; Louis H. Cochrane, engineer; William Duncanson, engine fitter; Henry Brown, engineer; William T. Hatch,

apprentice; Thomas Carlyle, draughtsman; Alfred J. Hill, draughtsman.

A TECHNICAL school is about to be established at Leicester, the main features of which will be to give instruction in the technology of spinning, and the technology of framework knitting. The governors of the Wyggeston Schools have given 1000*l.* towards this object, the Science and Art Department, South Kensington, has promised 500*l.*, 1000*l.* has been raised by subscription, and another 1000*l.* is all that is required to complete the scheme for the present. The movement has been undertaken by the Chamber of Commerce and the Rev. Canon Vaughan. Mr. Henry Mitchell, president of the Bradford Technical School, has received from the Worshipful Company of Clothworkers, London, an intimation to the effect that they have decided to give 300*l.* a year towards the maintenance of the school.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale des Sciences de Belgique, No. 5.—On the coralline origin of Devonian limestones of Belgium; reply to M. Dupont, by G. Dewalque.—Photography on the railway and in balloons, by R. Candèze.—On surfaces of involution, by E. Weyr.—On the integration of a class of equations with partial derivatives of the second order, by F. G. Teixeira.—Note on a new method for measuring the resistance of batteries, by P. Samuel.

Journal de Physique, June.—Electrical phenomena of hemihedral crystals with inclined faces, by Jacques and Pierre Curie.—Historical researches on the standards of weights and measures of the observatory, and the apparatuses that have served in their construction, by C. Wolf.—Units adopted for absolute measures by the International Congress of Electricians, by H. Pellat.—Thermodynamic analogy of thermoelectric phenomena and the phenomenon of Peltier, by E. Bouty.—Assimilation of the experiments of Hall and Faraday to the effects of the gyroscope, by B. Elie.—Magnetic gyroscope, by A. Crova.

Atti della R. Accademia dei Lincei; Transunti, vol. vi., fasc. 12.—On the pigments of bile, by S. Moreggia.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 17.—M. Blanchard in the chair.—The following papers were read:—Report on a memoir by M. Ph. Gilbert on various problems of relative motion, by a Committee. This memoir is a study of the motion of gyroscopic apparatus, viz. (1) Foucault's gyroscope; (2) the torse-pendulum, which the author modifies, getting a more sensitive form, the *barogyroscope*; this may be used instead of Foucault's instrument to prove the earth's rotation; (3) the top. The newest and most original part of the work is that relating to (2).—On a point of the theory of perturbations, by M. Radau.—Astronomical observations without measurement of angles, by M. Rouget. He designates them *circumzenithal*.—On the shock of a plane elastic plate, supposed indefinite in length and in width, by a solid which strikes it perpendicularly at one of its points, and which remains united to it, by M. Boussinesq.—On the variations of gravity, by M. Mascart. The idea of measuring variations of gravity at different points of the globe by the height of the mercury column which balances the pressure of a given mass of gas at constant temperature, M. Mascart has sought to realise, and he finds the method capable of great precision. He uses a kind of siphon-barometer with the short branch closed and holding CO_2, introduced at a pressure sufficient to balance a mercury column of 1 m., when the tube is vertical. The instrument is placed in a metallic cylinder filled with water, which is agitated by an air-current, and contains a thermometer measuring $\frac{1}{100}$ deg. The divided scale is fixed on the tube; one sees it by reflection on a gilt surface, which sends the virtual image into the axis of the tube, and the mercury is seen through the gold layer. Thus one can see, with a single microscope, the mercury-level and the corresponding division of the scale. M. Boussingault recalled having used a similar apparatus during his stay at Ecuador, near the mines of Marmato (1,600 m. alt.) Not finding any variation in the mercury column, he inferred there was no perceptible change in the intensity of gravity during the experiment.—On lightning conductors, by M. Melsens. In support of his system of multiple conductors forming a sort of cage, he cites the experiment in which animals within a metallic cage are unharmed by discharge of a powerful battery of Leyden jars through the cage.—On the hydrate of sulphuretted hydrogen, by M. de Forcrand. A claim of priority.—Researches on the use of crusher-manometers for measurement of pressures developed by explosive substances, by MM. Sarrau and Vieille. They attached to the piston of the crusher a thin piece of leaf-steel to mark a rotating blackened cylinder; and the curve, at explosion, was compared with a sinuous trace made by a tuning-fork at the same time. Results are promised soon.—On the limiting degrees of nitrification of cellulose, by M. Vieille. Cotton wadding was put in 100 to 150 times its weight of nitric acid of various degrees of concentration and at 11°. The last nitrated product obtainable thus is mononitrated cotton (liberating 108 c.c. of bioxide of nitrogen); it is got from nitric acid with 3 eq. of water (density 1·450). By use of sulphonitric mixtures, the author reached, as upper limit, a liberation of 214 c.c. of bioxide of nitrogen, nearly corresponding to the formula $C_{14}H_{29}(NO_4)_{11}O_{10}$.—Influence of compressibility of elements on compressibility of the compounds into which they enter, by M. Troost. The variation of the coefficient of compressibility of vapour of iodine appears again in the vapour of iodide of mercury.—On the derivatives of cupreous sulphites, by M. Etard.—On the gastric juice, by M. Chapoteaut. The aqueous solution of gastric juice (dried and washed previously with ether), treated with alcohol or sulphuric acid, gives a white precipitate, which appears to be the active principle of the juice; its composition is near that of albumen—On the products of distillation of colophany, by M. Renard.—On a new class of cyanised compounds with acid reaction; cyanomalonic ether, by M. Hailer.—On two new antiseptics, glyceroborate of calcium, and glyceroborate of sodium, by M. Le Bon. The latter (and better) has the advantage over carbolic acid of being soluble in water in all proportions, and quite harmless. For disinfection, meat preservation, &c., its fitness is established.—On the industrial conditions of an application of cold to destruction of germs of parasites in meat destined for food, by M. Carrè. With the author's apparatus as applied since 1876 in vessels for importation of meat from La Plata, &c., the cost price is slightly under 0·01 franc per kilogramme. The temperature of −40° or −50° applied for an hour or so is fatal to germs; this is reached in the domestic apparatus (with ammonia).—On the visibility of luminous points, by M. Charpentier. With equal brightness and distance this visibility is directly proportional to their surface, or the square of their diameter; with equal brightness and dimensions, inversely as the square of their distance from the eye; with equal dimensions and the same distance, directly as the illuminations.

CONTENTS

ex-
ned
the
for-
ner-
olo-
to
ark
was
the
ees
was
ous
uct
of
of
the
e of
O_{16}.
y of
ria-
line
eri-
ice,
ried
sul-
the
nen
-On
onic
e of
The
eing
For
1.—
ruc-
M.
5 in
cost
The
atal
with
har-
y is
heir
y as
ons